UTAH BUREAU OF LAND MANAGEMENT

Air Resource Management Strategy 2018 Air Monitoring Report

Cedar Mountain and Utah’s West Desert, Photo courtesy of Trisha Flores

1. Introduction

The Utah Bureau of Land Management (BLM) has prepared this air monitoring report in accordance with its 2018 Air Resource Management Strategy (ARMS) (BLM, 2018) and is the first of eight annual reports required under the provisions of the Southern Utah Wilderness Alliance, et al. v. U.S. Department of the Interior, et al. settlement agreement. The BLM authorizes activities that can affect air resources by releasing pollutants into the atmosphere. Air monitoring is an important element of the ARMS. The report assists the BLM in managing air resources by establishing current conditions and monitoring trends for National Environmental Policy Act (NEPA) analysis. Additionally the ARMS seeks to promote education, awareness, and transparency of air resources on public lands. Air pollution does not stop at government or jurisdictional boundaries and engaging the public, various levels of government, and tribes through cooperative airshed management is a key to protecting air quality. While air resource issues can be highly technical and complex, BLM Utah is making an effort in this report to meet the air monitoring and public awareness objectives of the ARMS and evaluate how air resources are being managed.

2. Regulatory analysis

Congress gave the Environmental Protection Agency (EPA) regulatory authority for cleaning up air pollution. Under the Clean Air Act (CAA), EPA sets limits on certain air pollutants, including setting limits on how much can be in the air anywhere in the United States. The Clean Air Act also gives EPA the authority to limit emissions of air pollutants coming from sources like chemical plants, utilities, and steel mills (EPA, The Plain English Guide to The Clean Air Act, 2007).

The Utah Division of Air Quality (DAQ) is responsible to ensure that air in Utah meets health and safety standards established under the CAA. To fulfil this responsibility, the DAQ is required by the federal government to ensure compliance with the EPA's National Ambient Air Quality Standards (NAAQS) statewide. Additionally the state ensures compliance with visibility standards through regional haze rules. The DAQ enacts rules pertaining to air quality standards, develops plans to meet the federal standards when necessary, issues preconstruction and operating permits to stationary sources, and ensures compliance with state and federal air quality rules (UDAQ, 2019).

EPA's Tribal Authority Rule gives Tribes the ability to develop air quality management programs, write rules to reduce air pollution and implement and enforce their rules in Indian Country. While state and local agencies are responsible for all CAA requirements, Tribes may develop and implement only those parts of the Clean Air Act that are appropriate for their lands (EPA, The Plain English Guide to The Clean Air Act, 2007).

While the EPA, State, and Tribes have regulatory authority to control air pollution emissions, it is the mission of the BLM to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations. Section 2.1 lists the laws, policy, and guidance that directs BLM how to achieve this mission with respect to air resources.

2.1. Regulations and Policy

Clean Air Act

The Clean Air Act (CAA) of 1963 as amended is the primary Federal legislation and provides the framework for protecting and enhancing the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population (Section 101(b)(1)). The Act focuses on reducing both criteria air pollutants and hazardous air pollutants. As required by the CAA, EPA has established NAAQS for criteria pollutants (Section 109 (a)(1)(A)). Compliance and enforcement of these Federal requirements may be delegated to applicable Tribal, State and local regulatory agencies (Sections 107(a), 301(d), 302). The CAA also allows these agencies to establish regulations which are more, but not less, stringent than the Federal requirement (Section 116) (EPA, The Plain English Guide to The Clean Air Act, 2007).

FLPMA

Federal Land Policy and Management Act (FLPMA) of 1976: Public Law 94-579, October 21, 1976, often referred to as the BLM's "Organic Act," provides the majority of the BLM's legislated authority, direction policy, and basic management guidance. This Act outlines the BLM's role as a multiple use land management agency and provides for management of the public lands under principles of multiple use and sustained yield. The Act also calls on the Secretary to "provide for compliance with applicable pollution control laws, including State and Federal air, water, noise, or other pollution standards or implementation plans" in the development and revision of land use plans (Section 202 (c)(8)). The Act further directs the Secretary of the Interior to take any action necessary to prevent unnecessary or undue degradation of the lands (Section 302 (b)). Congress' policy objective is to manage the public lands "in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values" (Section 102 (8)).

NEPA

National Environmental Policy Act (NEPA) of 1969: NEPA ensures that information on the potential environmental and human impact of Federal actions is available to public officials and citizens before decisions are made and before actions are taken. One of the purposes of the Act is to "promote efforts which will prevent or eliminate damage to the environment and biosphere," and to promote human health and welfare (Section 2). This Act requires that agencies prepare a detailed statement on the environmental impact of the proposed action for major Federal actions expected to significantly affect the quality of the human environment (Section 102 (C)). In addition, agencies are required, to the fullest extent possible, to use a "systematic, interdisciplinary approach" in planning and decision-making processes that may have an impact on the environment (Section 102(A)).

Additional Guidance

Other guidance and policy are useful for the BLM in managing air resources. While this guidance is not required by law it can be useful for managing and analyzing air resources. Such guidance includes, but is not limited to, the Memorandum of Understanding Among the Federal Land Management Agencies and EPA Regarding Air Quality Analyses and Mitigation for Federal Oil and Gas Decisions (MOU), Federal Land Managers' Air Quality Related Values Work Group (FLAG), BLM Utah Air Resource Management Strategy (ARMS), and Guidance for Conducting Air Quality General Conformity Determinations (BLM IM2013-025, 2012).

2.2. Regulated Air Pollutants

2.2.1. Criteria Air Pollutants

The EPA has established NAAQS for six common air pollutants (also known as "criteria air pollutants"). These pollutants are found all over the U.S. Concentrations of air pollutants greater than the national standards represent a risk to human health and the environment. Criteria pollutants include carbon monoxide, nitrogen dioxide, ozone, particulate matter, sulfur dioxide, and lead, and are discussed below. Periodically the EPA reviews the latest science to ensure that NAAQS appropriately protect human health and safety and to update the standards when necessary.

Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless gas emitted from combustion processes. The greatest sources of CO to outdoor air are cars, trucks and other vehicles or machinery that burn fossil fuels. CO can cause harmful health effects by reducing oxygen delivery to the body's organs (like the heart and brain) and tissues. At extremely high levels, CO can cause death (EPA, Criteria Air Pollutants, 2018).

Nitrogen Oxides

Nitrogen oxides (NO_x) are a group of highly reactive gasses. NO_x include nitrogen dioxide (NO_2), nitrous acid, and nitric acid. While EPA’s NAAQS covers this entire group of NO_x, NO_2 is the component of greatest interest and the indicator for the larger group of nitrogen oxides. NO_2 forms quickly from emissions from cars, trucks and buses, power plants, and off-road equipment. In addition to contributing to the formation of ground-level ozone, and fine particle pollution, NO_2 is linked with a number of adverse effects on the respiratory system (EPA, Basic Information about NO2, 2018).

Ozone

Ground-level ozone (O_3) is a secondary pollutant. It is formed by a chemical reaction between NO_x and volatile organic compounds (VOCs) in the presence of sunlight (photochemical oxidation). Precursor sources of NO_x and VOCs include motor vehicle exhaust, industrial emissions, gasoline vapors, vegetation emissions (i.e., terpenes), wood burning, and chemical solvents. Abundant solar radiation drives the photochemical process and creates ground-level O_3. Ozone is generally considered a summertime air pollutant (BLM 2012), but in certain parts of the country has become a winter time issue due to highly concentrated precursor pollutants in a low level temperature inversions and additional photochemical reaction from snow reflecting solar radiation back into the atmosphere.

Ozone is a regional air quality issue because, along with its precursors, it can transport hundreds of miles from its origins, and maximum O_3 levels can occur at locations many miles downwind from the sources. Primary health effects from O_3 exposure range from breathing difficulty to permanent lung damage. Significant ground-level O_3 contributes to plant and ecosystem damage (BLM 2012).

Particulate Matter (PM10 AND PM2.5)

Airborne particulate matter (PM) consists of tiny coarse-mode (PM_{10}) or fine-mode ($PM_{2.5}$) particles or aerosols combined with dust, dirt, smoke, and liquid droplets. $PM_{2.5}$ have diameters that are generally 2.5 micrometers or smaller and derived primarily from the incomplete combustion of fuel sources and secondarily formed aerosols. PM_{10} have diameters that are generally 10 micrometers or smaller and are derived primarily from crushing, grinding, or abrasion of surfaces. Sources of particulate matter include industrial processes, power plants, vehicle exhaust, fugitive dust, construction activities, home heating, and fires. Many scientific studies have linked breathing PM to serious health problems, including aggravated asthma, increased respiratory symptoms, difficult or painful breathing, chronic bronchitis, decreased lung function, and premature death. Particulate matter is a major cause of reduced visibility. It can stain and damage stone and other materials, including culturally important objects, such as monuments and statues (BLM 2012).

Sulfur Dioxide

Sulfur dioxide (SO_2) is one of a group of highly reactive gasses known as “oxides of sulfur.” The largest sources of SO_2 emissions are from fossil fuel combustion at power plants (73 percent) and other industrial facilities (20 percent). Smaller sources of SO_2 emissions include industrial processes such as extracting metal from ore, and the burning of high sulfur containing fuels by locomotives, large ships, and non-road equipment. SO_2 is linked with a number of adverse effects on the respiratory system (EPA, Sulfur Dioxide Basics, 2018).

Lead

Lead (Pb) is a metal found naturally in the environment as well as in manufactured products. The major sources of lead emissions have historically been from fuels in on-road motor vehicles (such as cars and trucks) and industrial sources. As a result of EPA's regulatory efforts to remove lead from gasoline, emissions of lead from the transportation sector declined by 95% between 1980 and 1999, and levels of lead in the air decreased by 94% during the same period. Major sources of lead emissions to the air today are ore and metals processing and piston-engine aircraft using leaded aviation gasoline (EPA, Basic Information about Lead Air Pollution, 2018).

National Ambient Air Quality Standards (NAAQS)

NAAQS have been established for the six criteria air pollutants to protect human health and welfare. The Utah DAQ is responsible to ensure compliance with the NAAQS within the state of Utah. Table 1 shows current NAAQS for the EPA designated criteria pollutants (EPA, National Ambient Air Quality Standards, 2018).

Table 1 Primary Criteria Pollutant NAAQS.

Pollutant	Primary/ Secondary	Averaging Time	Level*	Form
Carbon Monoxide (CO)	primary	8 hours	9 ppm	Not to be exceeded more than once per year
		1 hour	35 ppm	
Lead (Pb)	primary and secondary	Rolling 3 month average	0.15 µg/m^3	Not to be exceeded

Pollutant	Primary/ Secondary	Averaging Time	Level*	Form
Nitrogen Dioxide (NO_2)	primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	primary and secondary	1 year	53 ppb	Annual Mean
Ozone (O_3)	primary and secondary	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Fine Particulate Matter ($PM_{2.5}$)	primary	1 year	12.0 μg/m^3	Annual mean, averaged over 3 years
	secondary	1 year	15.0 μg/m^3	Annual mean, averaged over 3 years
	primary and secondary	24 hours	35 μg/m^3	98th percentile, averaged over 3 years
Coarse Particulate Matter (PM_{10})	primary and secondary	24 hours	150 μg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)	primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year
* Units of measure for the standards are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air (μg/m^3).				

2.2.2. Volatile Organic Compounds

Volatile organic compounds (VOC) means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates and ammonium carbonate, which participates in atmospheric photochemical reactions, except those designated by EPA as having negligible photochemical reactivity (EPA, Code of Federal Regulations, 40: Chapter 1, Subchapter C, Part 51, Subpart F, 51100, 2018). VOCs are regulated by the EPA to prevent the formation of ozone, a constituent of photochemical smog. VOC's in Utah originate mostly from biological sources such as vegetation and soils, chemical solvents, gasoline vapors, and oil and gas production (UDAQ, 2019). Many VOCs are also hazardous air pollutants.

2.2.3. Hazardous Air Pollutants (HAPs)

HAPs are known or suspected to cause cancer or other serious health effects, such as birth defects, or adverse environmental impacts. The EPA has classified 187 air pollutants as HAPs. Examples of listed HAPs associated with the oil and gas industry include formaldehyde, benzene, toluene, ethyl benzene, isomers of xylene (BTEX) compounds, and normal-hexane (n-hexane).

The CAA requires the EPA to regulate emissions of toxic air pollutants from a published list of industrial sources referred to as "source categories." The EPA has developed a list of source categories that must meet control technology requirements for these toxic air pollutants. Under Section 112(d) of the CAA, the EPA is required to develop regulations establishing national emission standards for hazardous air pollutants (NESHAP) for all industries that emit one or more of the pollutants in major source quantities. These standards are established to reflect the maximum degree of reduction in HAP emissions through application of maximum achievable control technology (MACT). Source categories for which MACT standards have been implemented include oil and natural gas production and natural gas transmission and storage.

Although HAPs do not have federal air quality standards (exposure thresholds do exist), some states have established "significance thresholds" to evaluate human exposure for potential chronic inhalation illness and cancer risks. There are no applicable federal or State of Utah ambient air quality standards for assessing potential HAP impacts to human health, and monitored background concentrations are rarely available. Therefore, reference concentrations (RfC) for chronic inhalation exposures and reference exposure levels (REL) for acute inhalation exposures can be applied as significance criteria. Table 2 below provides the RfCs and RELs. Both the RfC and REL guideline values are for non-cancer effects. The State of Utah has also adopted Toxic Screening Levels (TSLs) which are used during the air permitting process. These TSLs are not standards that must be met, but screening thresholds to determine if additional information is needed to evaluate potential health and environmental impacts.

Table 2 HAP Reference Exposure Levels and Reference Concentrations (RfCs)

HAP	**Reference Exposure Level (REL 1-hour Average) (μg/m^3)**	**Reference Concentration (RfC Annual Average) (μg/m^3)**
Benzene	1,300	30
	160,000 (1)	-
Toluene	37,000	5,000
Ethyl benzene	350,000 (1)	1,000
Xylenes	22,000	100
n-Hexane	390,000 (1)	700
Formaldehyde	94	9.8

[1] Immediately Dangerous to Life or Health/ because no REL is available

2.2.4. Air Quality Related Values

Air resources also encompass Air Quality Related Values (AQRVs). Air pollution can impact AQRVs through ambient exposure to elevated atmospheric concentrations, such as O_3 effects to vegetation, impairment of scenic views by PM in the atmosphere, and deposition of air pollutants, such as sulfur and nitrogen compounds on the earth's surface through dry and wet precipitation. AQRVs are identified and managed within the respective jurisdictions of several land management agencies in designated Class I areas (Federal Land Managers, 2010). The requirement to assess impacts to AQRVs is established in the CAA Prevention of Significant Deterioration (PSD) rules. PSD is a permitting program for new and modified major sources of air pollution that are located in attainment areas. The Federal land managers have the responsibility to consider whether new emissions from proposed major facilities (or modifications to major facilities) would have an adverse impact on AQRVs in Class I or sensitive Class II areas.

2.2.5. Greenhouse Gases

Greenhouse gases (GHGs) became regulated pollutants on January 2, 2011 under the PSD and Title V Operating Permit Programs (EPA, Clean Air Act Permitting for Greenhouse Gases, 2018) because of their contribution to global climate change effects. These gases absorb energy emitted from the earth's surface and re-emit a larger portion of the heat back to the earth rather than allowing the heat to escape into space than would be the case under more natural conditions. The EPA's GHG Tailoring Rule (40 CFR Parts 51, 52, 70, et al.) set initial emissions thresholds for PSD and Title V permitting based on carbon dioxide equivalent (CO_2e). These threshold apply to stationary sources that emit greater than 100,000 tons CO_2e per year (e.g., power plant, or landfill, etc.) or modifications of major sources with resulting emissions increase greater than 75,000 tons CO_2e per year.

In addition to the Tailoring Ruler the EPA requires reporting of GHGs from facilities with stationary sources that emit 25,000 metric tons CO_2e per year or more in the United States. The Mandatory Reporting Rule (40 CFR Part 98, Subpart C) does not require control of greenhouse gases, it only requires that sources above the threshold levels monitor and report emissions. This provides a basis for future EPA policy decisions and regulatory initiatives regarding GHGs.

2.3. Airsheds

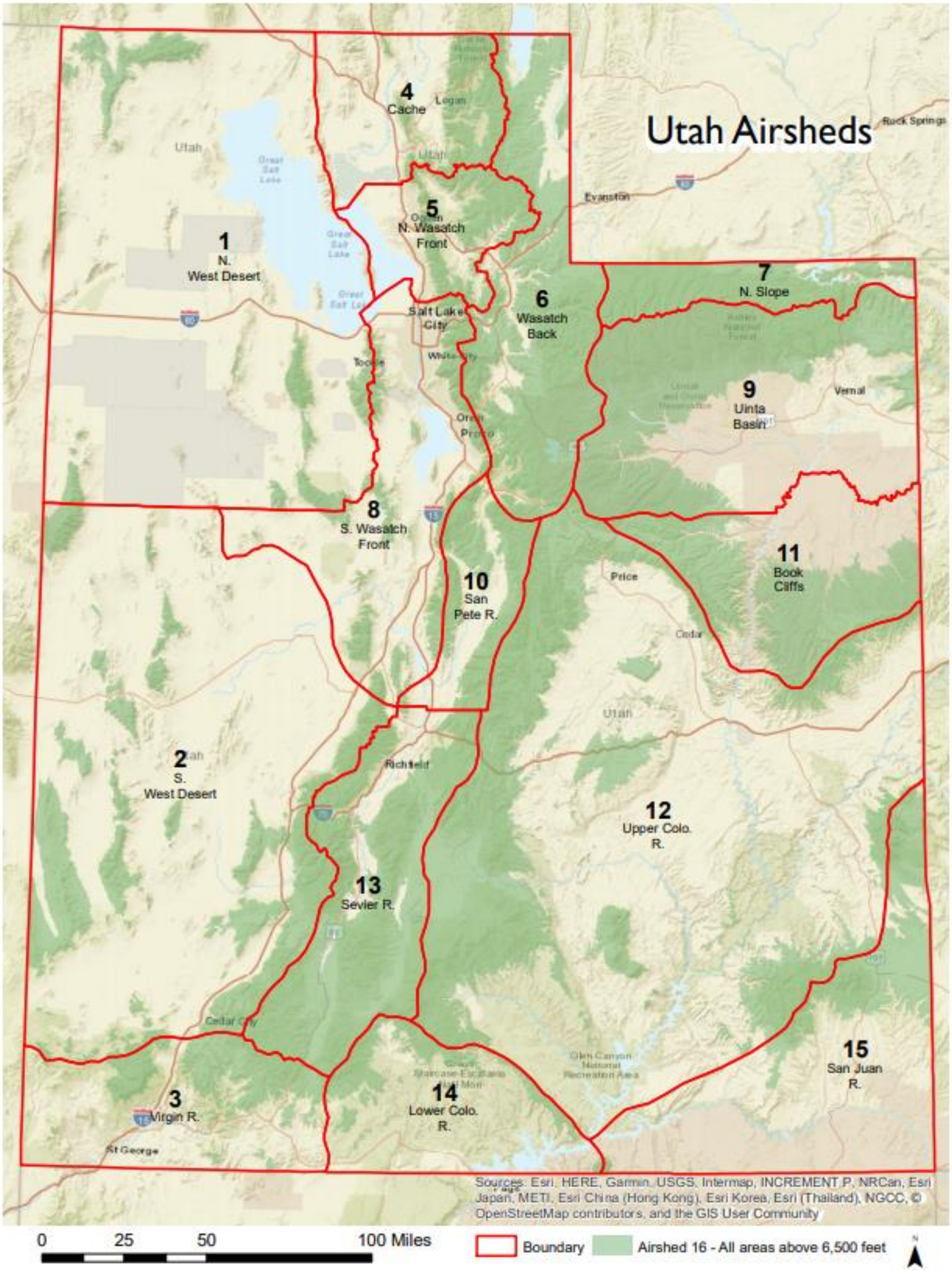
The airshed concept is a means for evaluating the local and regional air quality effects of a pollutant source. An airshed is a volume of air that is generally homogeneous with respect to atmospheric properties and the dispersion of air pollutants. In Utah geographical and meteorological constraints often define an airsheds boundaries and limit the dispersion of pollutants away from a source. The size of an airshed can vary from small valleys that are a few miles across to larger urban or regional areas that can be tens or hundreds of miles across.

Pollutants move through an airshed by two processes: transport and dispersion. Transport is movement caused by a time-averaged wind flow, with pollutants moving on scales of miles per hour. Dispersion is much smaller movement, primarily caused by localized turbulence on the scale of inches or feet. The transportation and dispersion extent of pollutants is the main factor for the area covered by an airshed.

2.3.1. Smoke Management Airsheds

The Utah Smoke Management Plan (UDAQ, Utah Smoke Management Plan, 2006) identifies sixteen airsheds in the state, Figure 1. While these airsheds were identified for the management of smoke related to prescribed fire, wildfire, and wildland fire, they are also useful for identifying areas of impacts from emissions of regulated air pollutants. Depending on source location and intensity, impacts may affect multiple airsheds or be confined to hotspots within an airshed.

Figure 1 Utah Smoke Management Airsheds



2.3.2. Class I & II Airsheds

Under the PSD provisions of the CAA, Congress established a land classification scheme for those areas of the country with air quality better than the NAAQS. Class I allows very little deterioration of air quality, Class II allows moderate deterioration, and in all cases, the pollution concentrations shall not violate any of the NAAQS. Congress designated certain existing areas as mandatory Class I which precludes re-designation to a less restrictive class, in order to acknowledge the value of maintaining these areas in relatively pristine condition. These mandatory Class I areas include: (1) international parks (2) national wilderness areas and national memorial parks in excess of 5,000 acres; and (3) national parks in excess of 6,000 acres existing as of August 7, 1977 (EPA, PSD Guidance Document, 1981). They are areas of special national or regional natural, scenic, recreational, or historic value for which PSD regulations provide extra protection. To prevent air quality in clean Class I and Class II airsheds from deteriorating to levels set by the NAAQS concentration increment levels have been established. PSD increments for Class I and Class II areas are listed in Table 3.

Table 3 PSD Increments (µg/m3)

Pollutant	Period	Class I	Class II
Nitrogen Dioxide	Annual	2.5	25
Sulfur Dioxide	3-hour	25	512
	24-hour	5	91
	Annual	2	20
Particulate Matter (< 10u)	24-hour	8	30
	Annual	4	17
Particulate Matter (< 2.5u)	24-hour	2	9
	Annual	1	4

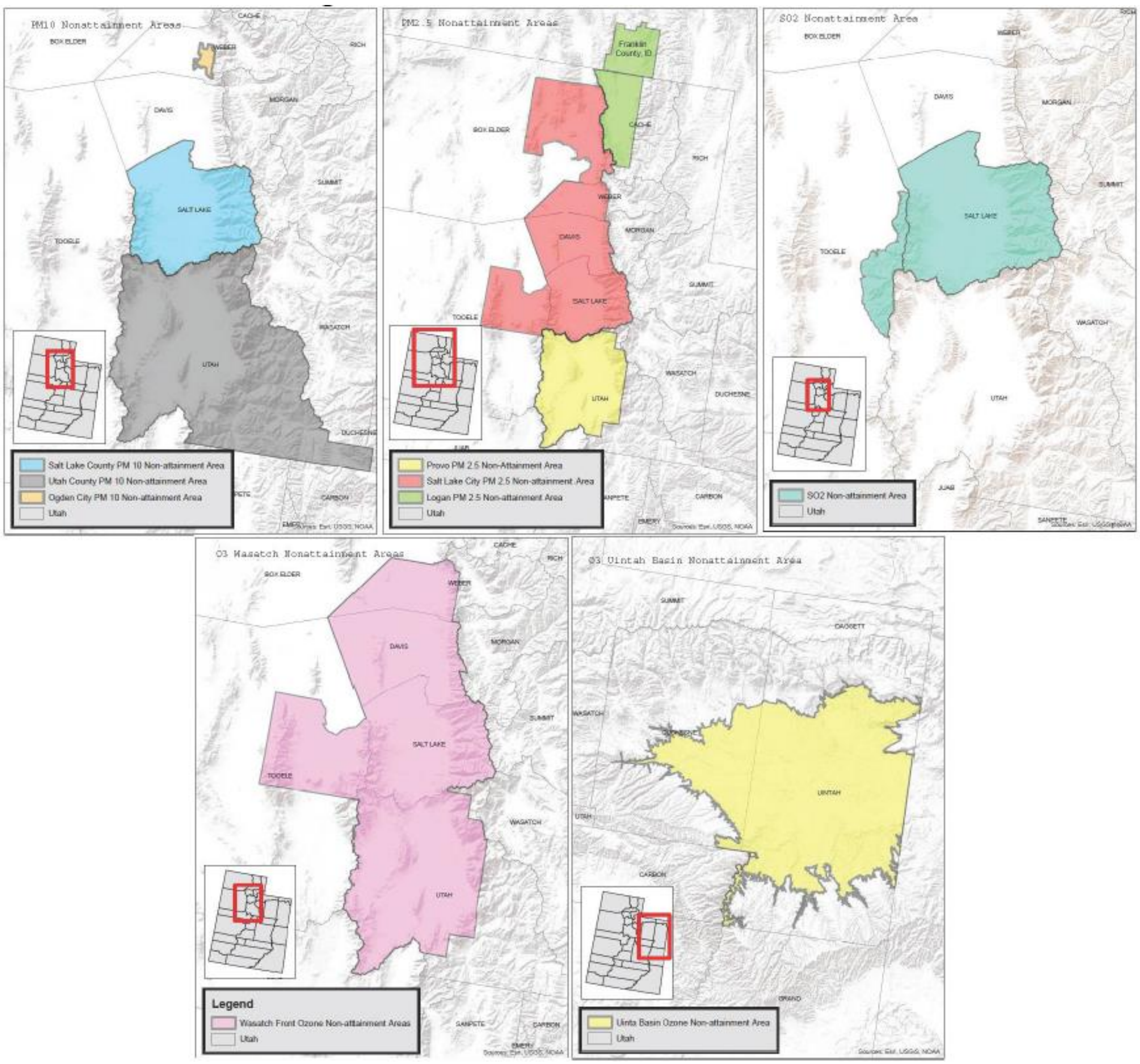
Source: *CFR 40 Chp1 SUBPART C, Part 52*

Utah has five Class I areas; Zion National Park (NP), Bryce Canyon NP, Capitol Reef NP, Canyonlands NP, and Arches NP. All portions of Utah outside Class I areas are designated Class II areas. There are currently no Class III areas defined in the U.S.

2.3.3. Nonattainment Areas (NAA)

Some airsheds in Utah violate the NAAQS standards for PM_{10}, $PM_{2.5}$, SO_2, and ozone. Parts of Salt Lake, Weber, and Utah counties previously exceeded CO standards and are now maintenance areas to ensure CO concentrations remain below the standard. On November 1, 2016, Governor Herbert submitted a recommendation to EPA that all areas of the state be designated as attainment for the 2010 SO2 NAAQS. On December 20, 2017, EPA sent a letter to Governor Herbert informing him that the agency concurs with Utah’s recommendations and is designating all areas of the state attainment/unclassifiable. The Salt Lake and Vernal BLM field offices are the only field offices with nonattainment areas (NAA). Pollution in NAAs along the Wasatch Front is primarily from urban and industrial sources, while high O_3 concentrations in the Uinta Basin NAA is primarily due to oil and gas related emissions. Figure 2 to shows the current NAAs in Utah.

Figure 2, PM_{10}, $PM_{2.5}$, SO_2, and O_3 Nonattainment Areas in Utah



Source: Utah Division of Air Quality 2018 Annual Report

2.4. Administrative Rules and Implementation Plans

To protect public health, the CAA (42 U.S.C Section 7401) requires that federal standards be set to limit the maximum levels of pollutants in the outdoor air. Each state is responsible for developing plans to demonstrate how those standards will be achieved, maintained, and enforced. These plans make up the State Implementation Plan (SIP). The Utah Air Quality Board enacts rules pertaining to air quality activities and develops SIPs to attain and maintain NAAQS. The plans and rules associated with them are enforced by the State, and, after federal approval, they are also federally enforceable. These plans are the framework for each state's program to protect the air. For Non-attainment areas not within state air regulatory jurisdiction a Federal Implementation Plan (FIP) or Tribal Implementation Plan is developed.

2.4.1. State

The State of Utah currently has areas that are in non-attainment for PM_{10}, $PM_{2.5}$, SO_2, CO, and O_3. SIP's developed for these areas can be found on the DAQ website (UDAQ, State Implementation Plan (SIP), 2018). On May 10, 2017 the EPA reclassified $PM_{2.5}$ non-attainment areas in Utah from Moderate to Serious. With the reclassification the State set about updating the SIP to include more stringent requirements. Revisions to the SIP include updated emissions inventories, evaluation and adoption of control measures for direct $PM_{2.5}$ and its precursors, application of Best Available Control Technology (BACT), attainment demonstration date, and a failure to attain plan. In 2018 portions of the Uinta Basin and Wasatch Front were classified as marginal non-attainment for ozone. A marginal classification does not require a SIP be developed.

2.4.2. Tribal/Federal

With the nonattainment designation in the Uinta Basin the EPA proposed amendments to the Federal Implementation Plan (FIP) for EPA's Indian Country Minor New Source Review (NSR) Program for Oil and Natural Gas Sources (EPA, Federal Indian Country Minor NSR Rule, 2016). The FIP is used instead of source-specific minor NSR preconstruction permits in Indian Country. It incorporates emissions limits and other requirements from eight federal standards, applying limits for a range of equipment and processes used in oil and natural gas production and natural gas processing. The amendment would allow the FIP to continue to be used in portions of the Uinta Basin classified nonattainment for ozone.

2.4.3. Utah Administrative Code

Administrative rules are laws affecting the legal rights and privileges of the public or other governmental entities, and have all the effects of a statute enacted by the Legislature. Rules are created by agencies of the state's executive branch, are enacted as laws under regulatory authority granted by the Legislature or the state Constitution, and are subordinate to statutes. In short, the Legislature has created a method by which Executive branch agencies can codify their own policies and procedures and give them the force of law. Administrative rules go through an approval process which includes a public comment period (UOAR, 2019). Utah administrative code R307 contains state rules related to air quality and control of air pollution sources in the state.

3. Air Quality Conditions and Trends

3.1. Criteria Air Pollutants (CAPs)

Air Quality Index

Air quality for each field office is examined using the EPA Air Quality Index Summary Report (EPA, 2018) and from nearby air monitoring stations. The Air Quality Index (AQI) is an indicator of overall air quality as it accounts for all criteria air pollutants in a county and is one way to quickly evaluate how clean or polluted the air is. The EPA calculates a daily AQI based on local air monitoring data. The terms "Good", "Moderate", and "Unhealthy" help to interpret the AQI. When the AQI value is in the good range, pollutant concentrations are well below the NAAQS and air pollution poses little or no risk. Moderate AQI values occur when pollution is below but near the NAAQS and voluntary emission reduction measures are encouraged. The AQI is considered unhealthy when the NAAQS is exceeded and major pollution sources are often required to implement mandatory emission reduction measures. Counties without AQI data usually have fewer air pollutant sources and are assumed to have good air quality. Statistical AQI data from 2015 to 2017 is presented in Table 4. Additional AQI data is presented in Appendix A (Cedar City Field Office) through Appendix J (Vernal Field Office).

Table 4 AQI Index Summary Statistics by County

		# of Days When AQI was…			% of Days Rated …		
County	**# Days with AQI**	**Good**	**Moderate**	**Unhealthy**	**Good**	**Moderate**	**Unhealthy**
Box Elder County, UT	1096	773	303	20	71%	28%	2%
Cache County, UT	1096	828	239	29	76%	22%	3%
Carbon County, UT	969	692	275	2	71%	28%	0%
Davis County, UT	1088	747	292	49	69%	27%	5%
Duchesne County, UT	1096	831	245	20	76%	22%	2%
Garfield County, UT	509	444	63	2	87%	12%	0%
Salt Lake County, UT	1096	542	459	95	49%	42%	9%
San Juan County, UT	1058	852	205	1	81%	19%	0%
Tooele County, UT	1096	827	241	28	75%	22%	3%
Uintah County, UT	1096	731	341	24	67%	31%	2%
Utah County, UT	1096	634	417	45	58%	38%	4%
Washington County, UT	1096	829	263	4	76%	24%	0%
Wayne County, UT	285	284	1	0	100%	0%	0%
Weber County, UT	1096	671	370	55	61%	34%	5%

Air Quality Design Values

Design values can be used to further evaluate the air quality for areas with poor air quality. A design value describes the air quality of a location with respect to the NAAQS, and are typically used to classify NAA and evaluate progress towards meeting the NAAQS. The EPA annual publishes the most recently computed design values (EPA, Air Quality Design Values, 2019). The $PM_{2.5}$ and O3 design values for Utah are presented in Table 5 to Table 8. Design values for PM_{10}, NO_x CO, SO_x, and lead can be found on the EPA website (EPA, Air Quality Design Values, 2019).

The most recent design values show that only Salt Lake County is exceeding the NAAQS for $PM_{2.5}$, while Dave, Duchesne, Salt Lake, Tooele, Uintah, Utah, and Weber counties are exceeding the NAAQS for O_3.

Table 5 Design Value History for Previously Designated Nonattainment Areas for the PM2.5 2006 24-hour NAAQS

NAA	2006-2008 $\mu g/m^3$	2007-2009 $\mu g/m^3$	2008-2010 $\mu g/m^3$	2009-2011 $\mu g/m^3$	2010-2012 $\mu g/m^3$	2011-2013 $\mu g/m^3$	2012-2014 $\mu g/m^3$	2013-2015 $\mu g/m^3$	2014-2016 $\mu g/m^3$	2015-2017 $\mu g/m^3$
Logan	36	40	46	42	37	46	45	45	34	33
Provo	44	50	41	42	35	47	45	47	31	31
Salt Lake City	46	48	44	45	38	40	43	45	42	37

Table 6 PM2.5 County-level Summary for Annual and 24-hour Design Values

County	2015-2017 Annual $\mu g/m^3$	2015-2017 24-hour $\mu g/m^3$	Meets NAAQS?
Box Elder	7.2		Yes
Cache	7.5	34	Yes
Davis	7.8	29	Yes
Duchesne	6.1	24	Yes
Salt Lake	8.7	37	No
Utah	8.2	31	Yes
Washington	4.9	13	Yes
Weber	8.8	33	Yes

Table 7 Design Value History in Areas Designated Nonattainment for the 2015 8-Hour Ozone NAAQS

NAA	2006-2008 ppm	2007-2009 ppm	2008-2010 ppm	2009-2011 ppm	2010-2012 ppm	2011-2013 ppm	2012-2014 ppm	2013-2015 ppm	2014-2016 ppm	2015-2017 ppm
Northern Wasatch Front	0.082	0.077	0.074	0.074	0.075	0.076	0.075	0.076	0.075	0.078
Southern Wasatch Front	0.076	0.072	0.070	0.068	0.070	0.073	0.074	0.072	0.073	0.072
Uinta Basin				0.100	0.101	0.106	0.094	0.093	0.080	0.088

Table 8 County-Level Design Values for the 2015 8-hour Ozone NAAQS

County Name	2015-2017 ppm	Meets NAAQS?
Box Elder	0.067	Yes
Carbon	0.067	Yes
Davis	0.075	No
Duchesne	0.077	No
Salt Lake	0.078	No
San Juan	0.064	Yes
Tooele	0.073	No
Uintah	0.088	No
Utah	0.072	No
Washington	0.066	Yes
Weber	0.073	No

Monitoring Data

State, Federal, and Tribal agencies operate a number of air pollutant monitoring stations across the State of Utah. Air pollutant data from these stations is available on the EPA Air Data website (EPA, 2018). Most air monitors are situated to measure air quality in both neighborhoods and industrial areas. A few stations are located in rural areas by various Federal agencies to monitor air quality conditions and trends at National Parks and other public lands, and to identify background concentrations away from major emission sources. The UDAQ Air Quality 2018 Annual Report shows air pollutant trends for state run monitoring stations (UDAQ, 2019). Air monitoring data from the current year is not analyzed as data is incomplete for the year, in the process of being quality assured, and considered preliminary until May 1 of the following year.

3.2. Air Quality Related Values (AQRV)

3.2.1. Visibility

Pollution in the atmosphere can impair scenic views by degrading the contrast, colors, and distance an observer is able to see. Visibility can be assessed in terms of the distance that a person can distinguish a large dark object on the horizon and is measured as the standard visual range in miles. Average natural visual range conditions for Class I areas can be found in FLAG (U.S. Forest Service, National Park Service, and U.S. Fish and Wildlife Service, 2010). Visual range for Class I areas in Utah varies from 247-285 km depending on time of year and location.

A deciview is a unit of measurement to quantify human perception of visibility. It is derived from the natural logarithm of atmospheric light extinction coefficient. A one deciview change is roughly the smallest perceptible change in visibility. Since visibility at any one location is highly variable throughout the year, it is characterized by three groupings: the clearest 20% days, average 20% days, and haziest 20% days. Visibility degradation is primarily due to sulfate, nitrate, and particulate emissions.

Visibility is monitored using methodologies established by the Interagency Monitoring of Protected Visual Environments (IMPROVE) Program. The particulates that contribute to haze are collected on filters at each IMPROVE site. Samples are then measured to determine how visibility is impacted over time and by which pollutants. Figure 3 to Figure 8 (FLM, 2018) illustrate visibility trends based on air monitoring data from local IMPROVE sites. Each national park shows an improving trend in clearest and haziest days, except Great Basin which shows no improvement or worsening for the time period. The trend is statistically significant for the haziest days at Bryce Canyon, Canyonlands, Zion, and Mesa Verde National Parks. The trend is statistically significant for the clearest days at Canyonlands, and Mesa Verde National Parks.

Figure 3, Visibility Trends at Bryce Canyon NP

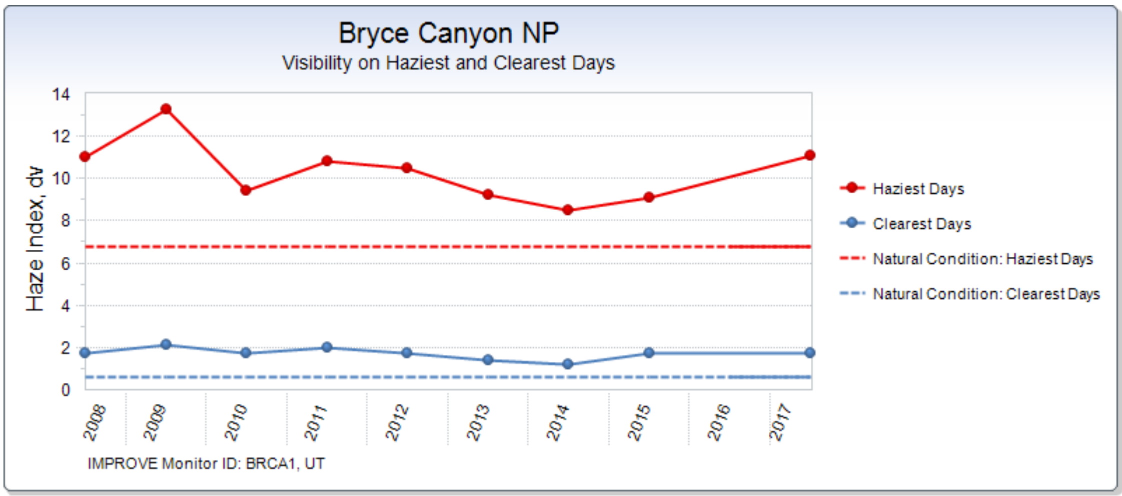


Figure 4, Visibility Trends at Canyonlands NP

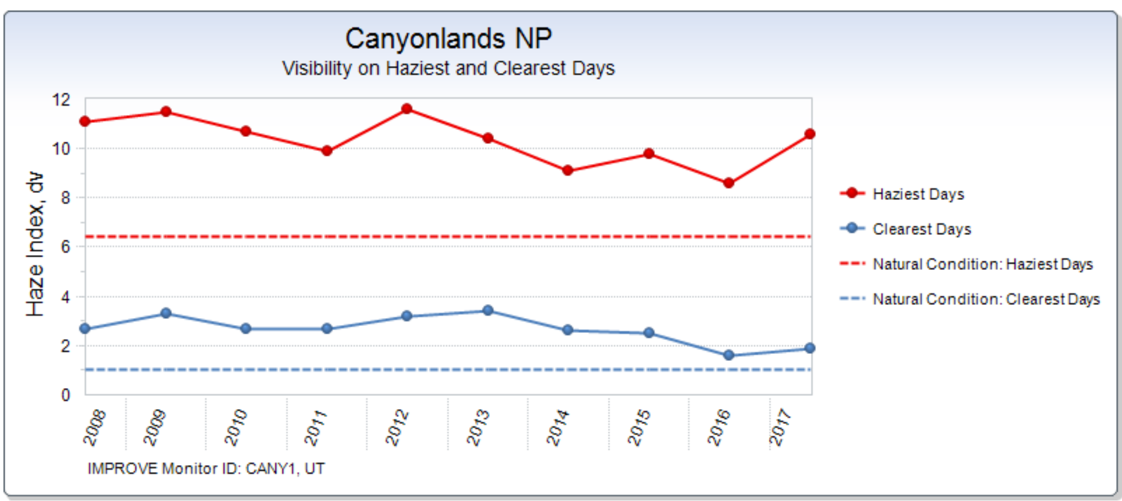


Figure 5, Visibility Trends at Capitol Reef NP

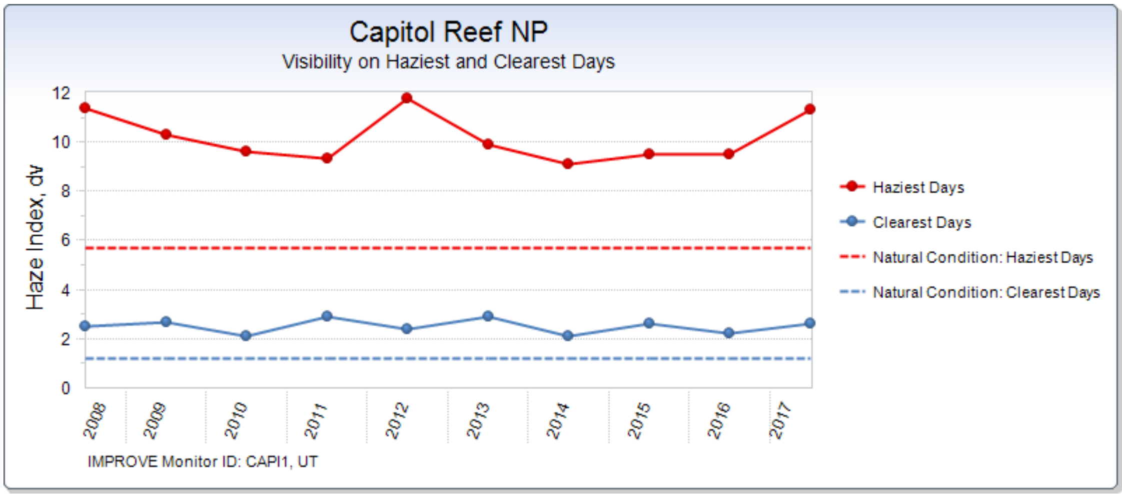


Figure 6, Visibility Trends at Great Basin NP

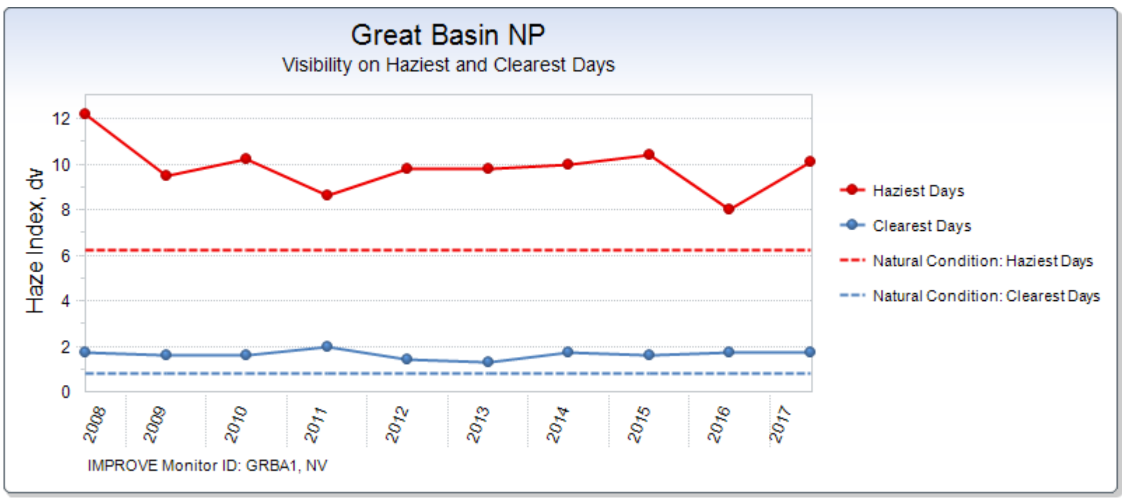


Figure 7, Visibility Trends at Mesa Verde NP

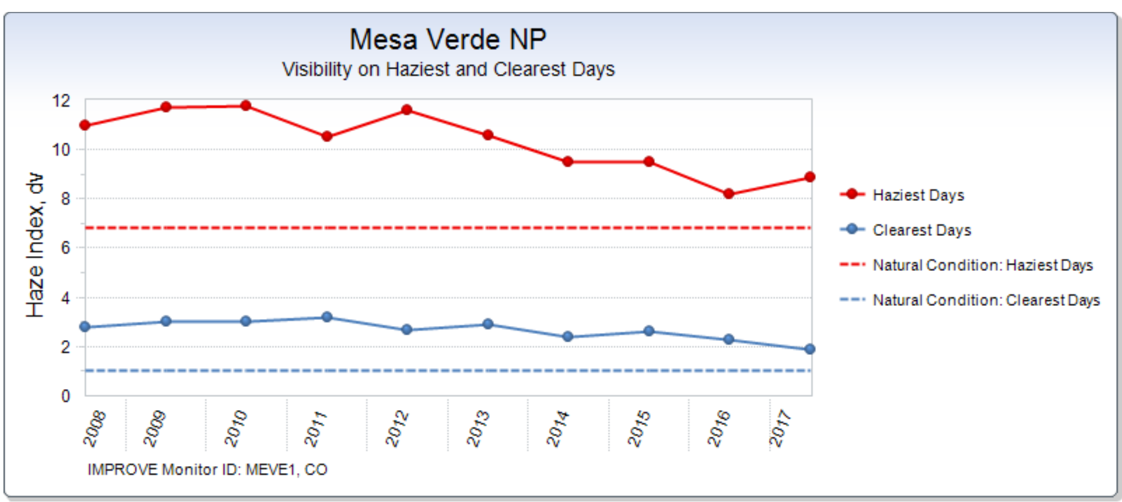
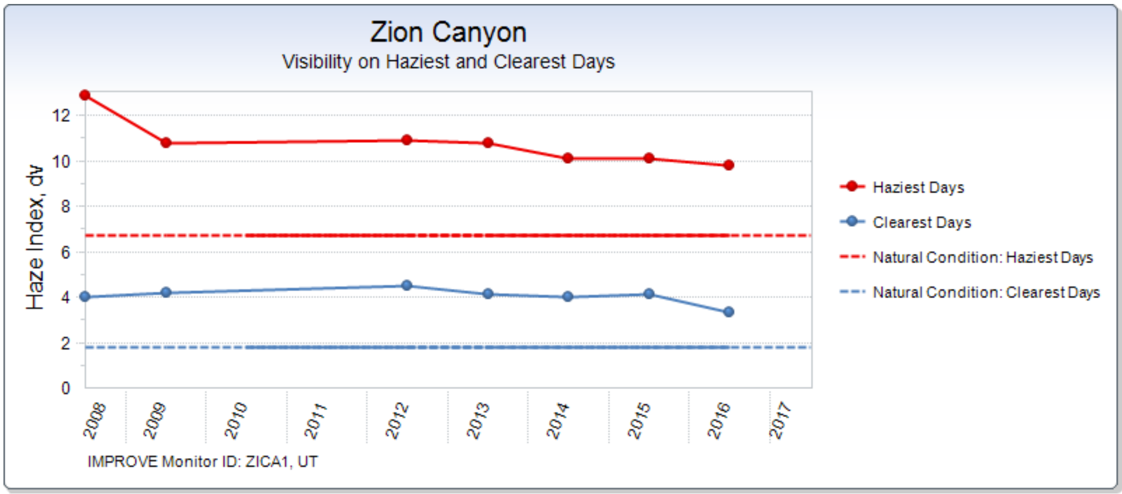


Figure 8, Visibility Trends at Zion NP

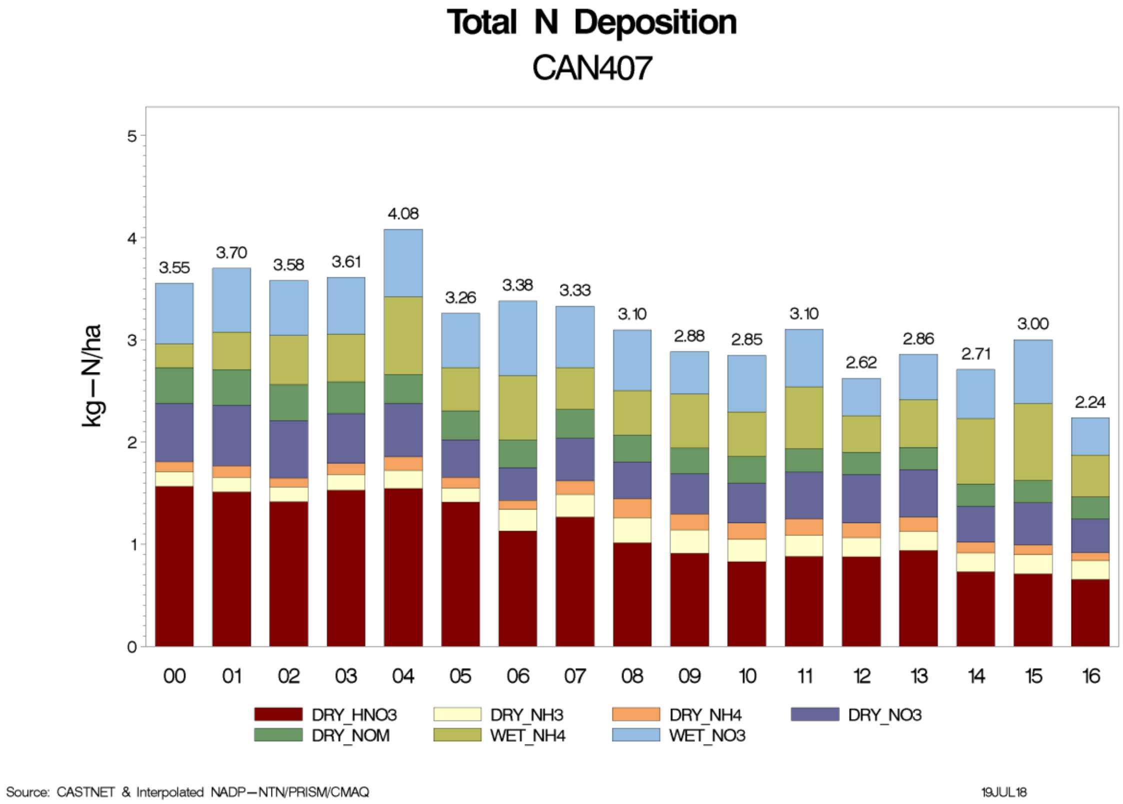


3.2.2. Deposition

Atmospheric deposition occurs when gaseous and particulate air pollutants are deposited on the ground, water bodies or vegetation. The pollutants may settle as dust or be washed from the atmosphere in rain, fog, or snow. When air pollutants such as sulfur and nitrogen are deposited into ecosystems, they may cause acidification, or enrichment of soils and surface waters. Atmospheric nitrogen and sulfur deposition may affect water chemistry, resulting in impacts to aquatic vegetation, invertebrate communities, amphibians, and fish. Deposition can also cause chemical changes in soils that alter soil microorganisms, plants, and trees. Excess nitrogen from atmospheric deposition can stress ecosystems by favoring some plant species and inhibiting the growth of others. Information on wet and dry deposition at Class I areas can be found at EPA's Clean Air Status and Trends Network monitoring program (EPA, CASTNET, 2019). Active CASTNET stations in Utah are located at Dinosaur National Monument (DIN431) and Canyonlands National Park (CAN407). Additional stations at Great Basin National Park (GRB411) and Mesa Verde National Park (MEV405) may be representative for some parts of Utah. Total nitrogen and sulfur deposition from for these parks are presented in Figure 9 to Figure 12.

The National Parks Service monitors and evaluates deposition to determine parks most at risk and where conditions are declining or improving (NPS, 2018). Evaluation of nitrogen deposition at Canyonlands and Great Basin National Parks warrants significant concern due to moderate levels of wet deposition and sensitivity of ecosystems. At Mesa Verde and Zion National Parks wet nitrogen deposition warrants moderate concern. Sulphur deposition at Canyonlands and Zion National Parks is in good condition. Wet sulfur deposition warrants significant concern at Great Basin National Park and moderate concern at Mesa Verde National Park.

Figure 9, Total Nitrogen and Sulfur Deposition at Canyonlands NP



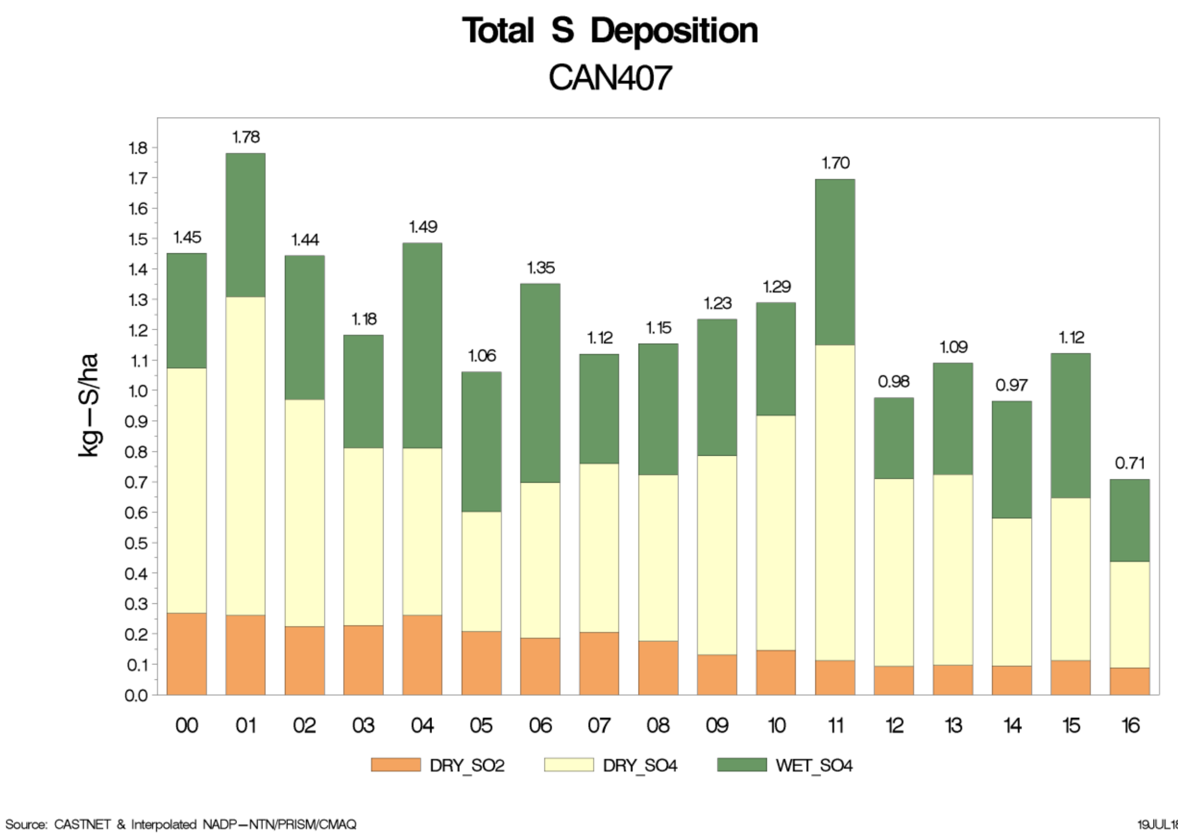
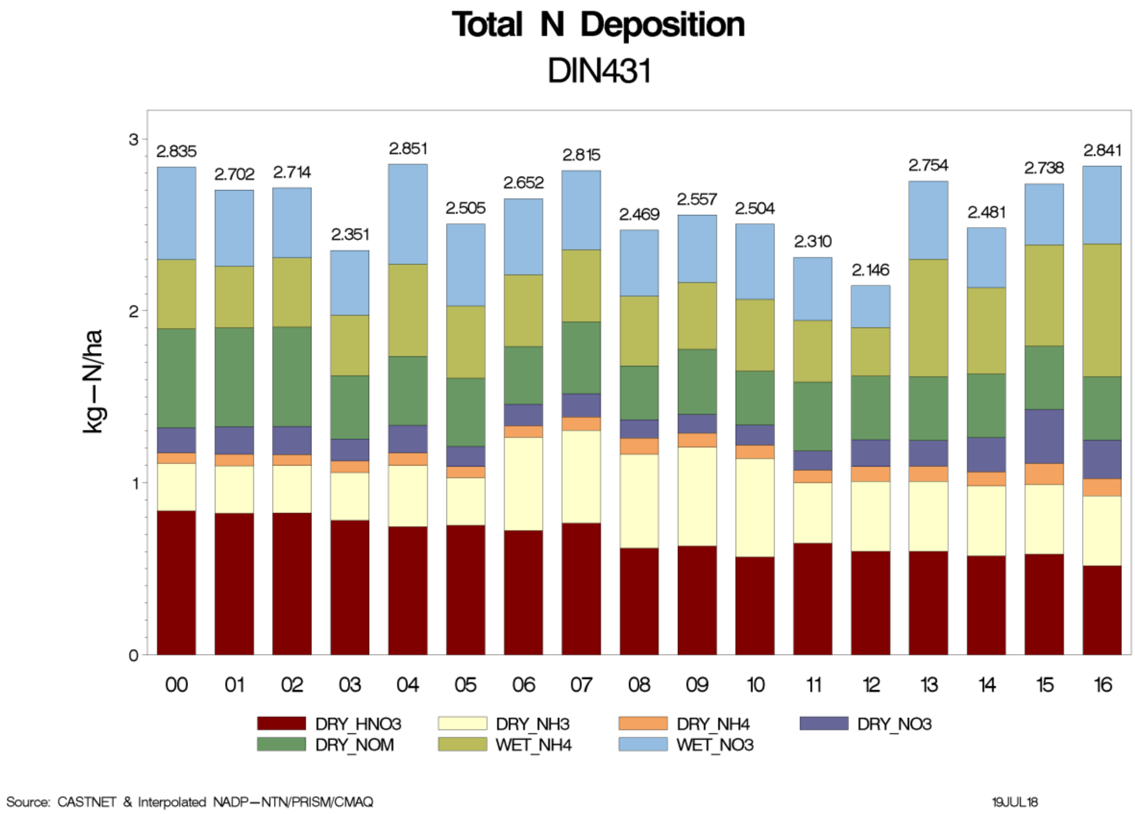


Figure 10, Total Nitrogen Deposition at Dinosaur NM



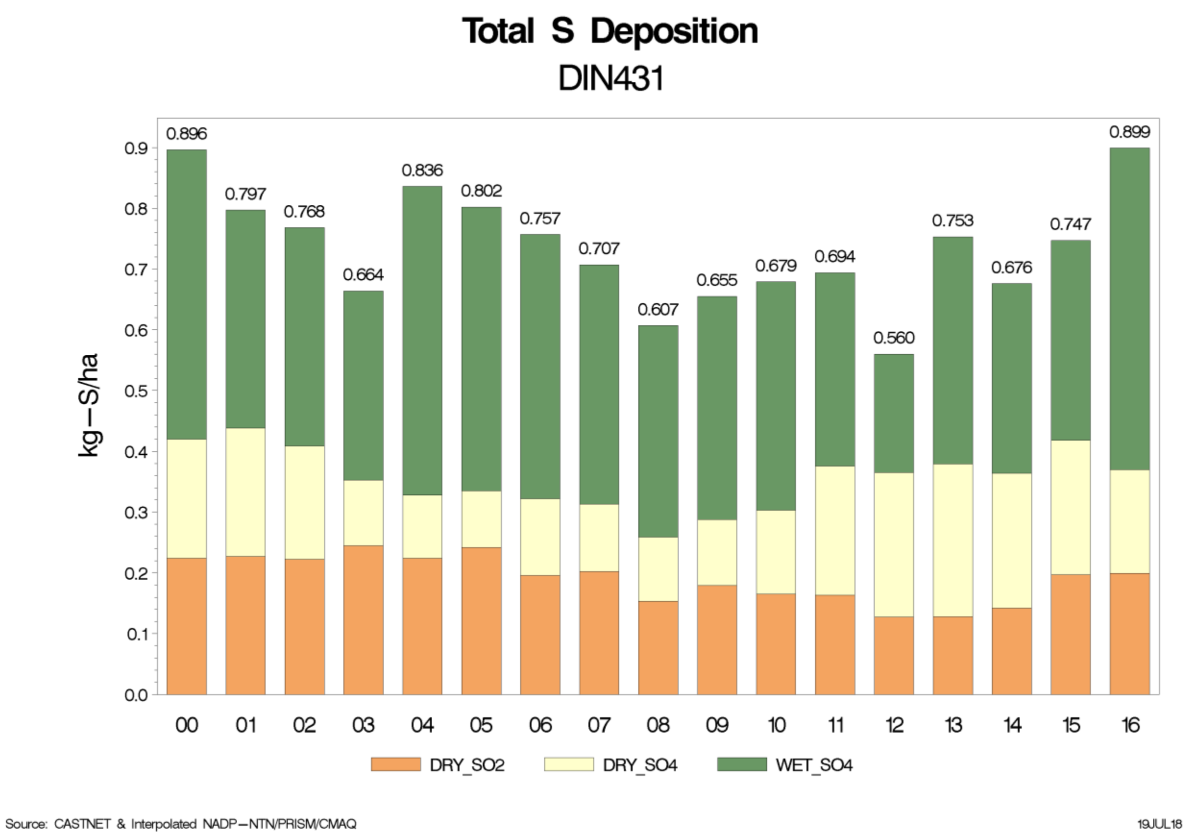
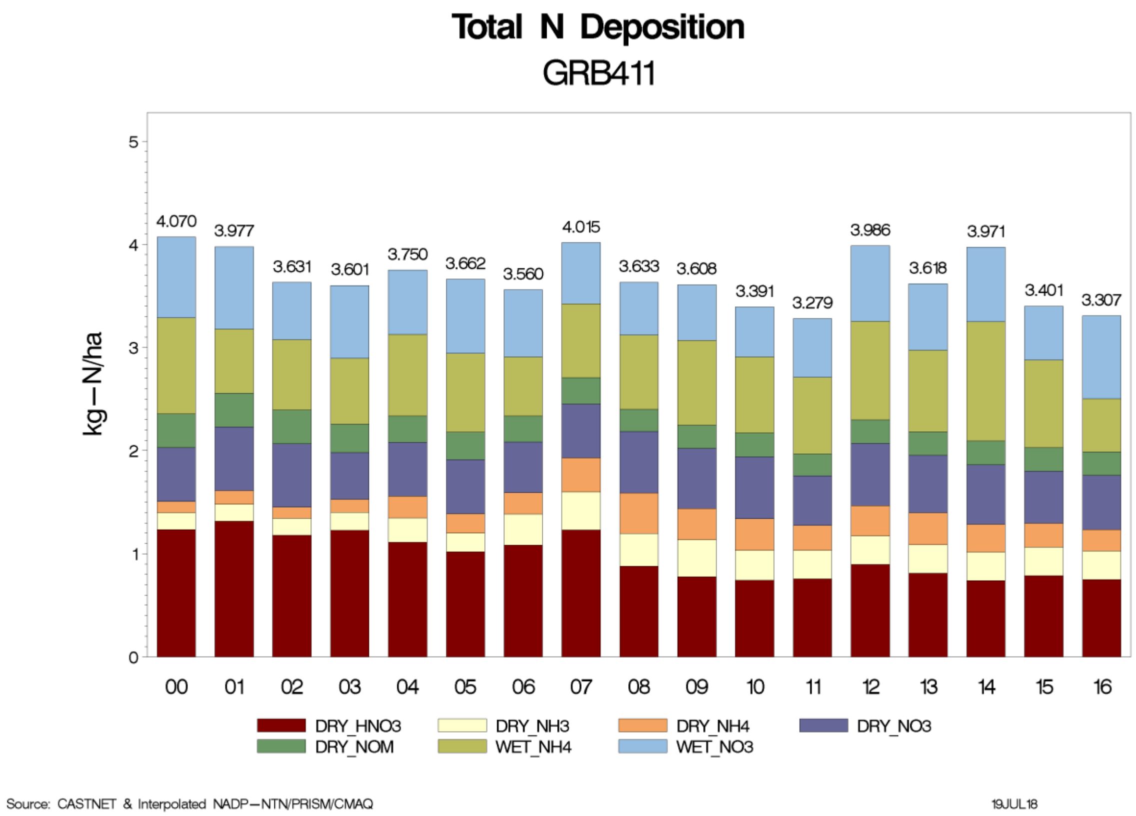


Figure 11, Total Nitrogen Deposition at Great Basin NP



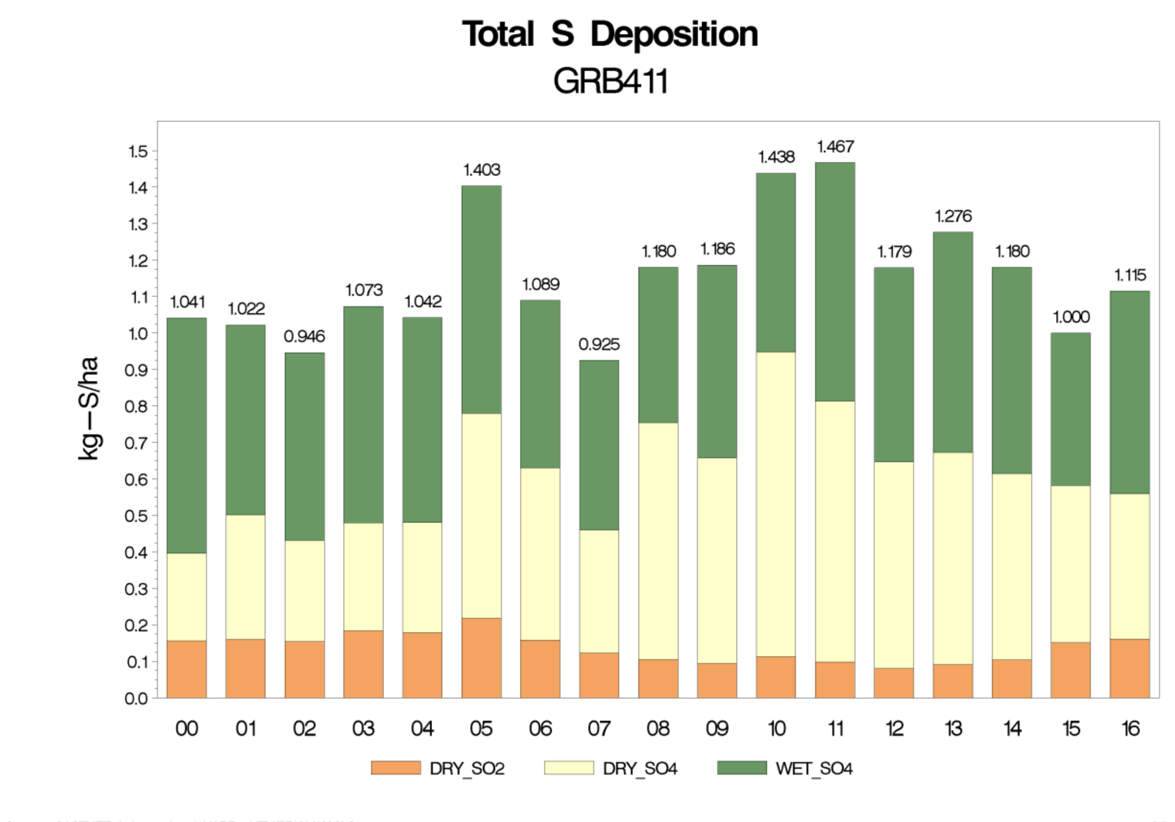
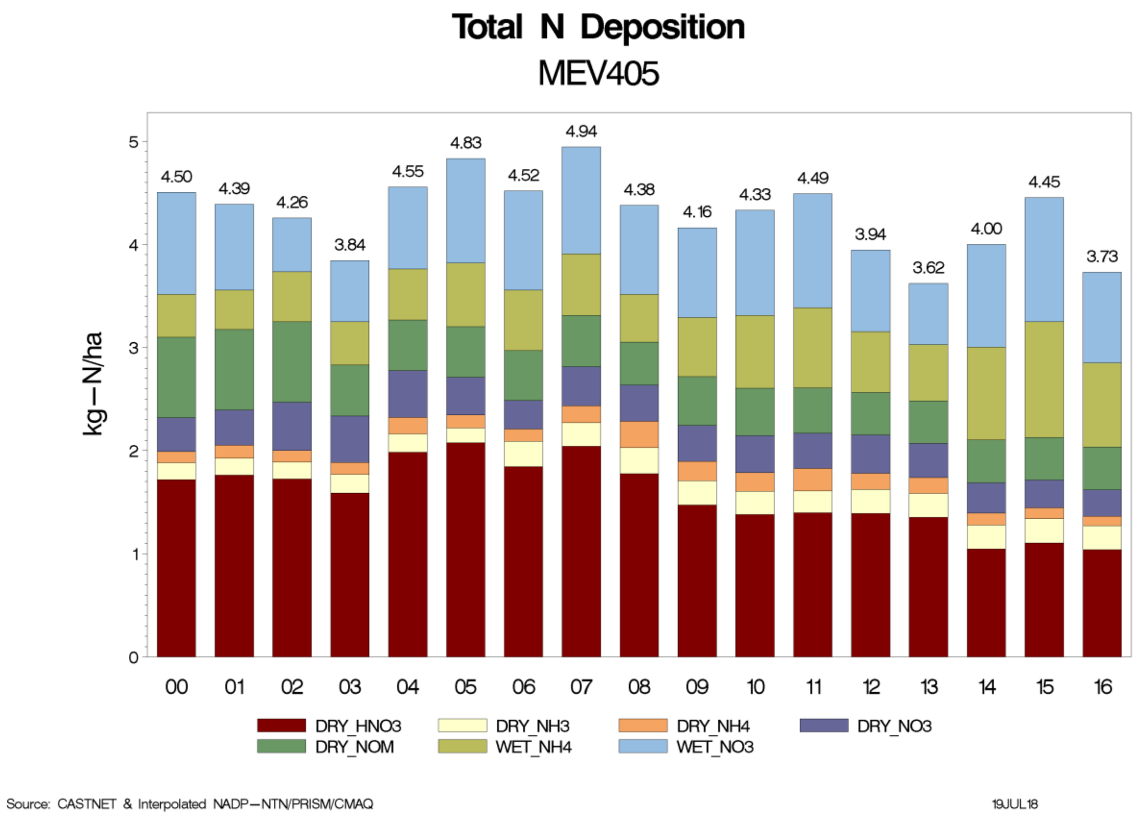
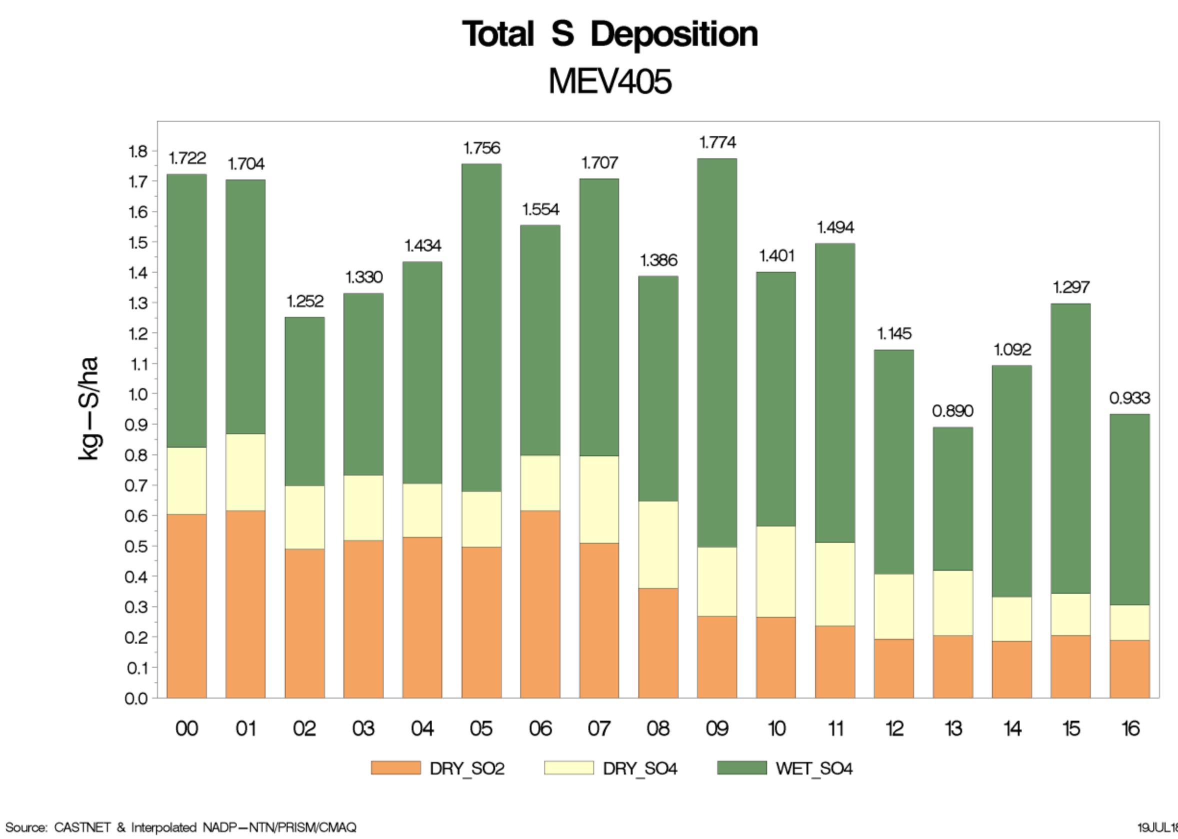


Figure 12, Total Nitrogen Deposition at Mesa Verde NP





3.3. National Emission Inventory

The National Emissions Inventory (NEI) is a comprehensive and detailed estimate of air emissions of criteria pollutants, criteria precursors, and hazardous air pollutants. The NEI is released every three years based primarily upon data provided by State, Local, and Tribal air agencies for sources in their jurisdictions and supplemented by data developed by the US EPA. The NEI is built using the Emissions Inventory System (EIS) first to collect the data from State, Local, and Tribal air agencies and then to blend that data with other data sources (EPA, National Emissions Inventory, 2018).

The NEI includes emissions estimates for area, point, and mobile sources (UDAQ, 2018). Point sources include large industrial sources, usually with emissions over 100 tons/yr., and New Source Performance Standard sources. Area emission sources are those that are too small or too numerous to be treated as point sources. Residential heating, agricultural dust, asphalt paving, solvent use, and oil and gas production are examples of area sources. Biogenic and event sources such as wildfires are also considered area sources but reported separately. Mobile sources include emissions from both on-road and non-road vehicles that use gasoline, diesel, and other fuels. On-road sources include cars, light and heavy duty trucks, and motorcycles. Non-road sources include lawn and garden equipment, locomotives, airplanes, recreation vehicles, marine vessels and commercial engines. Point source emission data is collected under the authority of Utah Administrative code R307-150 (Utah, 2018). Area sources are collected using local demographic information, energy and agricultural data, and submitted inventories. Mobile data is calculated using vehicle miles traveled and mobile emissions factors from the EPA.

Criteria Pollutant Emissions

Statewide emissions data from UDAQs 2014 State Summary of Emissions by Source Report (UDAQ, 2018) is presented in Table 9. County level emissions data is provided in Appendix A (Cedar City Field Office) through Appendix J (Vernal Field Office). Counties with little or no BLM managed land are omitted but can be found in the UDAQ report. Omitted counties include Cache, Weber, Morgan, Davis, Salt Lake, Summit, and Wasatch. The largest anthropogenic sources of CAPs in Utah are on-road mobile sources for CO, point sources for NO_x and SO_x, area sources for PM_{10} and $PM_{2.5}$, and Oil and Gas sources for VOCs.

Table 9, 2014 Criteria Air Pollutant Emissions (tpy) in Utah by Source

State	Source	CO	NOx	PM10	PM2.5	SOx	VOCs
Utah	Area Sources	36,713.5	13,937.5	153,057.8	22,816.2	170.6	33,417.2
	Area Sources Oil and Gas	15,444.7	16,404.2	790.5	564.5	291.5	178,518.3
	Non-Road Mobile	121,315.9	17,287.8	1,528.1	1,449.4	214.3	20,066.5
	On-Road Mobile	203,288.5	60,952.1	12,425.8	4,277.6	294.6	20,487.0
	Point Sources	23,175.9	63,141.8	10,303.5	5,635.7	25,561.6	5,848.1
	Point Portable	83.5	228.4	93.1	17.8	38.9	51.0
	Biogenics	143,712.4	0.0	0.0	0.0	0.0	692,037.4

State	Source	CO	NOx	PM10	PM2.5	SOx	VOCs
	Wildfires	5,793.3	164.9	701.0	630.9	0.0	989.6
	State Total	**549,528**	**172,117**	**178,900**	**35,392**	**26,572**	**951,415**

HAP Emissions

Hazardous air pollutants (HAPs), also known as toxic air pollutants, are known or suspected to cause cancer or other serious health effects. HAPs emitted by the oil and gas industry include benzene, toluene, ethyl benzene, mixed xylenes, formaldehyde, normal-hexane, acetaldehyde, and methanol. A list of HAP point source emissions by County is published by the UDAQ (UDAQ, 2018) as part of the NEI.

4. Climate and Green House Gases

Climate describes what the weather is like over a long period of time in a specific area. Different regions can have different climates. Climate is often described by looking at the average meteorological conditions, such as precipitation and temperature, which occur over long periods at a particular place. Climate change is the change in the typical average meteorological conditions of a place. While climate is always changing much of the recent observed changes are linked to rising levels of greenhouse gases in the atmosphere (EPA, Climate Change Indicators in the United States, 2016).

4.1. Utah Climate Narrative

Utah climate is determined by its inland location, distance from the equator, elevation, wide range of topography, and location with respect to storm paths across the western United States. Elevations range from 2,500 feet in the southwest part of the state to 13,500 feet in the Uinta Mountains. Mountain ranges such as the Sierra Nevada and Cascade Ranges also influence climate in Utah. Pacific storms must cross these ranges before reaching Utah where much of the moisture in the storms falls as precipitation. Consequently storms reaching Utah are relatively dryer and produce less precipitation (WRCC, 2018).

The National Center for Environmental Information (NCEI) divides Utah into seven climate divisions; Western, Dixies, North Central, South Central, Northern Mountains, Uinta Basin, and Southeast (Figure 13). Divisions in Utah are organized based on areas with similar terrain and weather stations observing the same general climate conditions. Since the climate divisions are based on topography they loosely align with smoke management airsheds (Figure 1). All climate divisions in Utah have some general similarities such as winter having the highest amount of monthly precipitation.

Most Utah climate divisions are classified as semiarid. Divisions with mountainous areas and higher elevation valleys are characterized as Humid Continental with no real dry season and warm-to-hot summers. The Northern Mountains, portions of the Uinta Basin, Southeast, and North and South Central divisions all have mountains and high elevation valleys. Winters are severe with cold temperatures and abundant snowfall. The Uinta Mountains and other mountainous areas with elevations over 11,000 feet are classified as sub-arctic. Here there is no dry season.

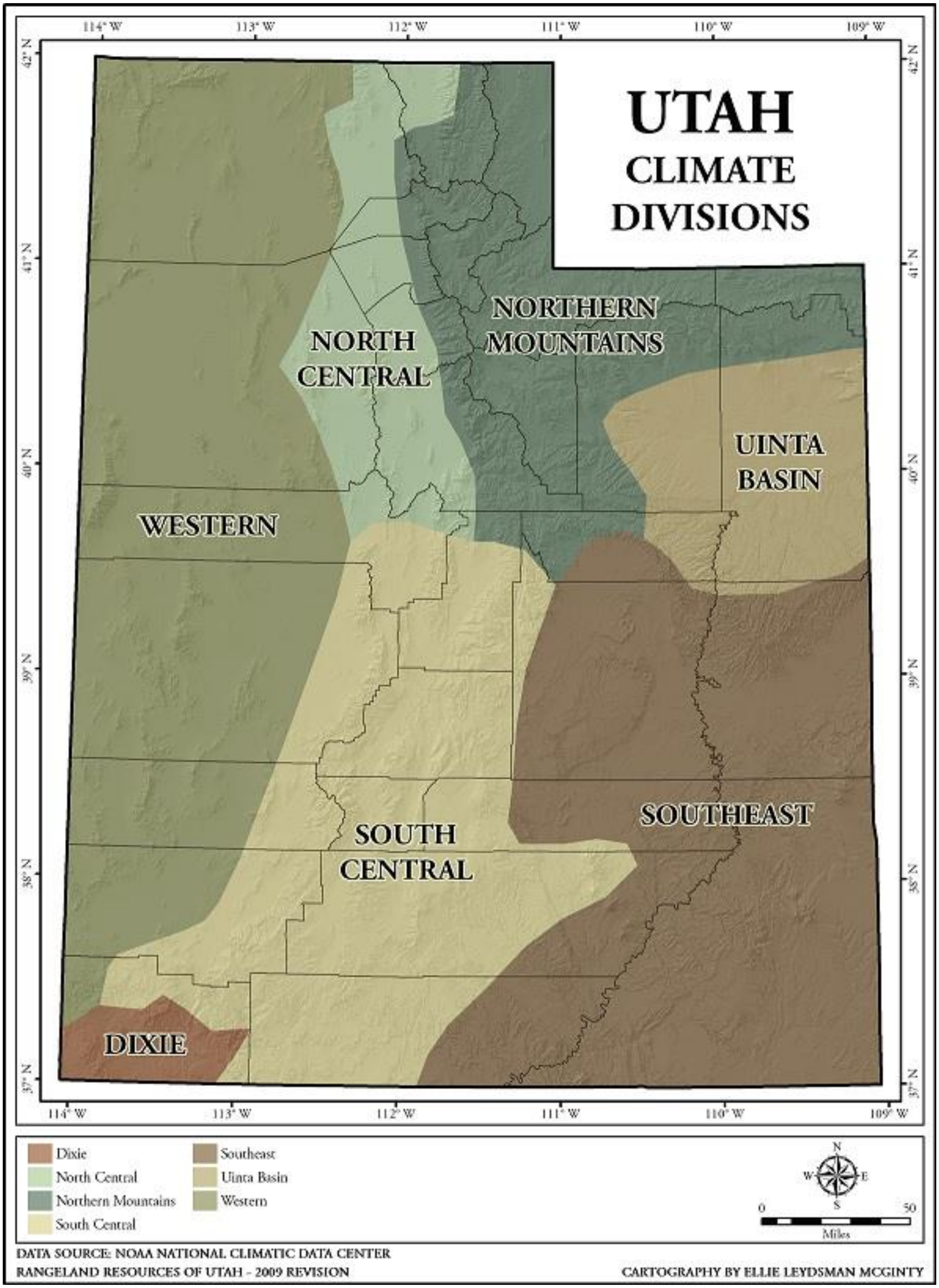
Cool summers and severe, cold winters characterize these mountain areas (Utah Climate Center, 2009).

In the northwest, most precipitation falls during the winter and spring months, while thunderstorms fueled by moisture from the North American Monsoon provide summer precipitation in the east and south. Annual precipitation is highly variable across the state, with annual totals ranging from less than 5 inches in portions of the Great Salt Lake Desert to more than 20 inches in some mountain locations. Snowfall varies widely across the state, with portions of the south receiving less than 10 inches annually while areas in the mountains can receive over 400 inches per year. The area around the Great Salt Lake can receive substantial snowfall due to lake effect snow events. As the state has warmed, the percentage of precipitation falling as snow during the winter has decreased, as has snow depth and snow cover. Runoff from melting mountain snow usually reaches a peak in April, May or early June, and sometimes causes flooding along lower streams. Although floods are rare in the state, both heavy rainfall and snowmelt can result in severe flooding. Historically, floods of both types have had devastating impacts. In 1983, melting of a large snowpack during the months of April to June caused mudslides and extensive flooding in the Salt Lake Valley. In January 2005, heavy rains in the Virgin River basin caused severe flooding, resulting in over $150 million in damage. Flash floods from summer thunderstorms are more frequent, but usually affect small areas. Since snowmelt from the snowpack provides water for many river basins, abnormally low winter and spring precipitation is often the trigger for drought conditions (Frankson, 2017).

Temperatures range from an average low of 15 degrees Fahrenheit (°F) in the winter to an average high of 90°F in the summer. The mountains and elevated valleys have cooler temperatures, with lower areas of the state having higher temperatures. There is about a 3° F decrease in mean annual temperature for each 1,000-foot increase in altitude, and approximately 1.5 to 2° F decrease in average yearly temperature for each one degree increase in latitude. Average yearly temperatures also decrease by 1 to 2°F (0.6 to 1°C) for each one-degree increase in latitude. Southern Utah counties can average 6 to 8°F (3.5 to 4.5°C) warmer than northern counties at similar altitudes. Utah experiences wide ranges in temperature during the course of the day as heat quickly builds during the day and rapidly dissipates at night (WRCC, 2018). The rapid surface cooling at night often creates a temperature inversion. During the winter months high atmospheric pressure can persist over the western United States for several weeks, creating strong inversions. When these inversion develop in areas with pollutant sources air quality often degrades until a strong storm can clear out the stagnant air.

Winds are generally moderate but at times can reach damaging proportions. Strong wind events in Utah are often associated with storm fronts, canyon winds, or down slope wind events. Dust storms occasionally occur in western Utah.

Figure 13, NOAA National Centers for Environmental Information Climate Divisions



4.2. Climate Indicators

One important way to track the causes and effects of climate change is through the use of indicators. Climate indicators show trends over time in key aspects of the environment. Many indicators are meteorological related. Other indicators include greenhouse gas emissions, sea level, growing season length, ecosystems, and others. Only climate indicators related to air resources are discussed in this document.

4.2.1. Climate Normals

Climate Normals are three-decade averages of climatological variables including temperature and precipitation. This product is produced once every 10 years. The 1981–2010 U.S. Climate Normals dataset is the latest release. It contains daily and monthly Normals of temperature, precipitation, snowfall, heating and cooling degree days, frost/freeze dates, and growing degree days calculated from observations at approximately 9,800 stations (NOAA, 2018). Climate Normals representative for each field office are found in the climate normal section of Appendix A (Cedar City Field Office) through Appendix J (Vernal Field Office). Climate normals include seasonal and annual averages of average maximum and minimum temperature, and average precipitation and snowfall. Prevailing wind information is also presented in wind roses and monthly tables, but are only available for airports with continuous measurements. Wind roses are a polar plot to graphically show wind speed and direction.

4.2.2. Trends

Trend analysis is a technique used to estimate future conditions based on historically observed trends. The main assumption behind trend analysis is that what happened in the past is expected to happen in the future. Historical temperature and precipitation information for each Utah climate division is presented in Table 10. Information presented include annual average temperature and precipitation from 1895 through 2017 and trends from the most recent Climate Normal period. For each BLM field office additional annual average and trend information can be found in Appendix A (Cedar City Field Office) through Appendix J (Vernal Field Office). It should be noted that recent precipitation trends show a decrease ranging from -0.51 to -1.49 inches per decade. This decrease is likely due to historically high precipitation that fell in the early 1980's and precipitation totals in more recent years closer to the long-term average. Graphical representation of historical annual total precipitation (1895-2017) and trends from the current climate normal period (1981-2010) are shown in Figure 14 through Figure 20. Historical annual average temperature (1895-2017) and trends from the current climate normal period (1981-2010) are shown in Figure 21 through Figure 27.

Table 10, Climate Trends

Climate Division	1895-2017 Mean		1981-2010 Trend	
	Temp (F)	Precip (in)	Temp (F)	Precip (in)
1, Western	49.6	9.81	+ 0.5	-0.76
2, Dixie	58.5	12.94	+ 0.6	-0.60
3, North Central	47.9	16.7	+ 0.6	-1.49
4, South Central	46	15.71	+ 0.5	-0.78
5, Northern Mountains	40.1	23.46	+ 0.5	-1.32
6, Uinta Basin	45.1	10.72	+ 0.5	-0.65
7, Southeast	51.5	9.8	+ 0.5	-0.51

Figure 14, Utah Western Climate Division 1 Precipitation Trend

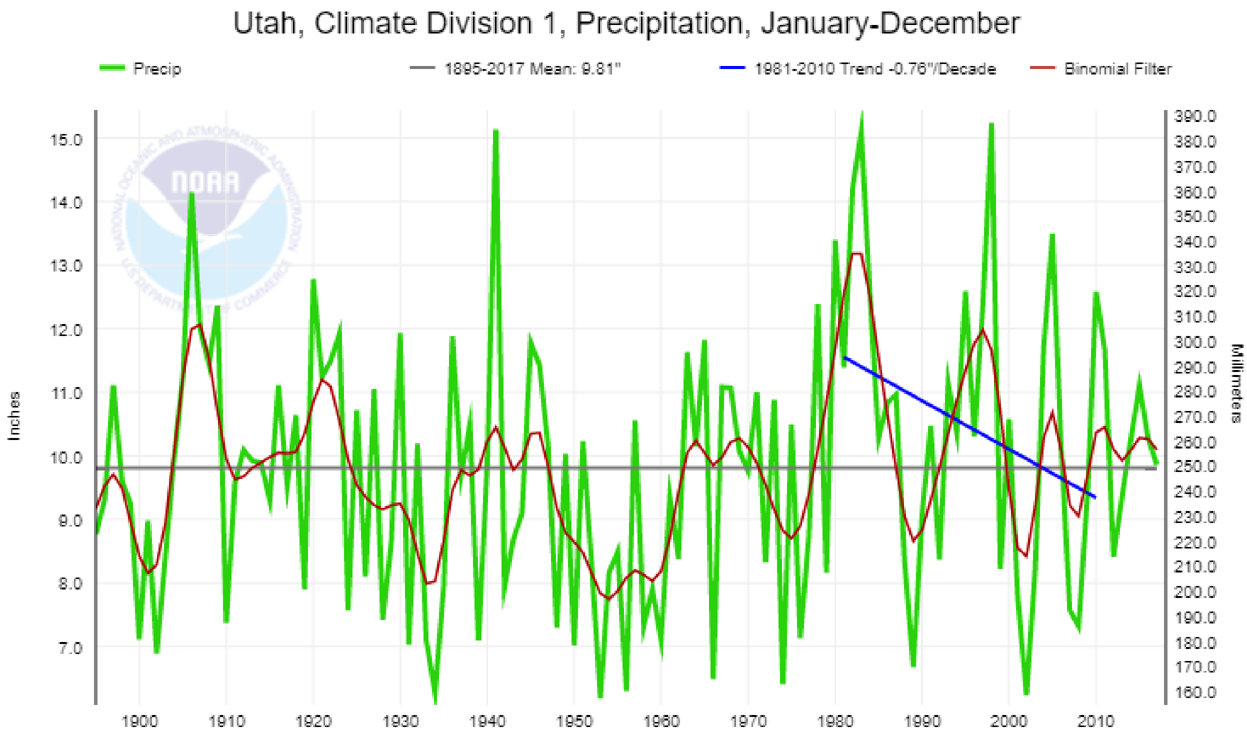


Figure 15, Utah Dixie Climate Division 2 Precipitation Trend

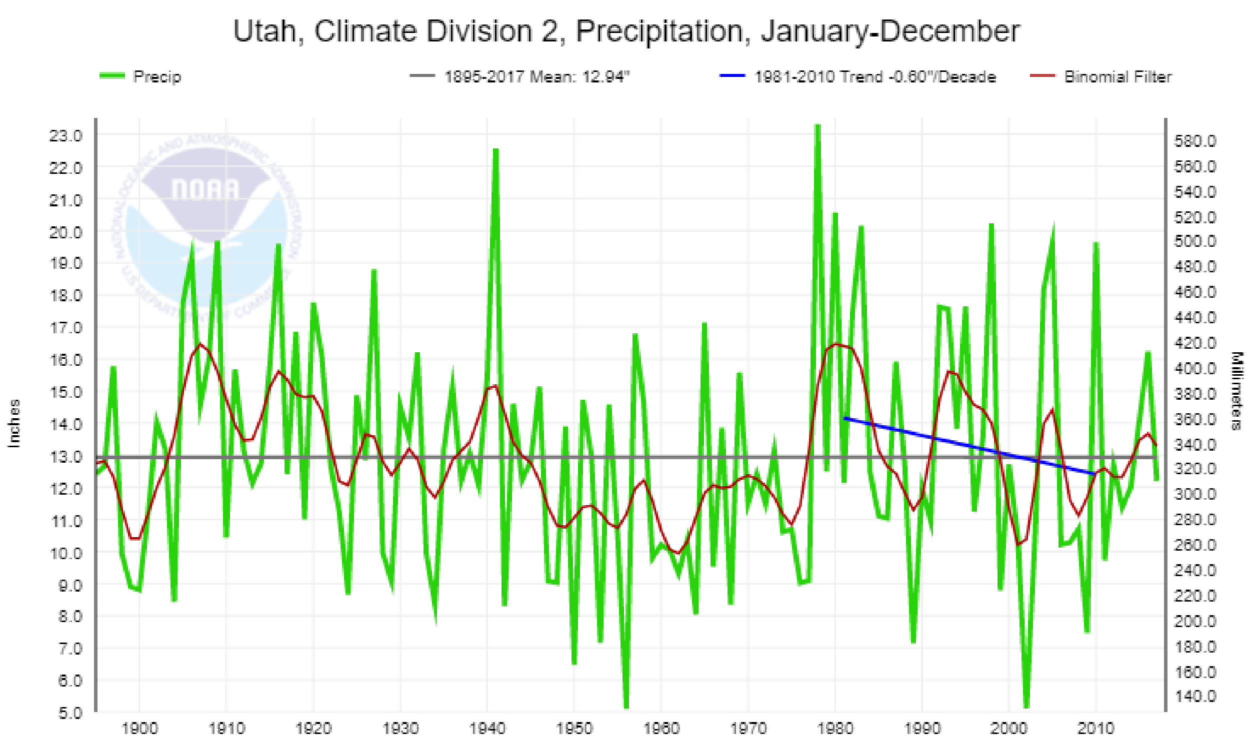


Figure 16, Utah North Central Climate Division 3 Precipitation Trend

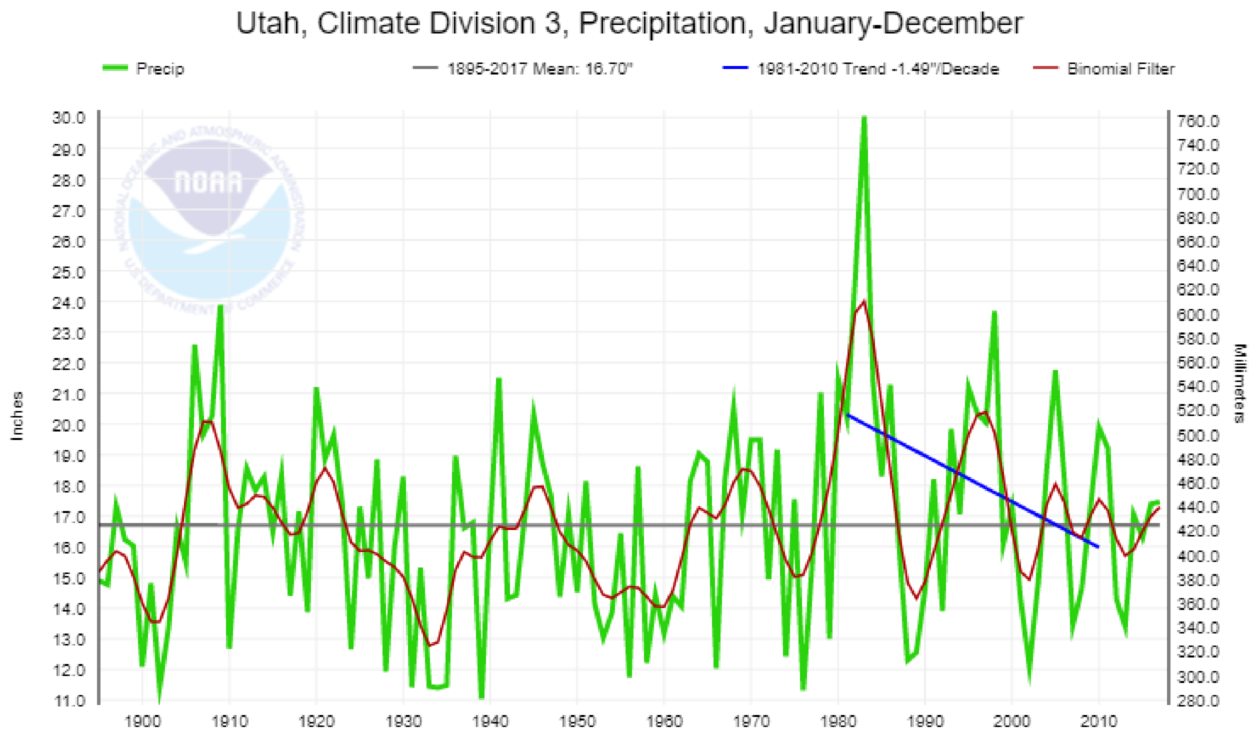


Figure 17, Utah South Central Climate Division 4 Precipitation Trend

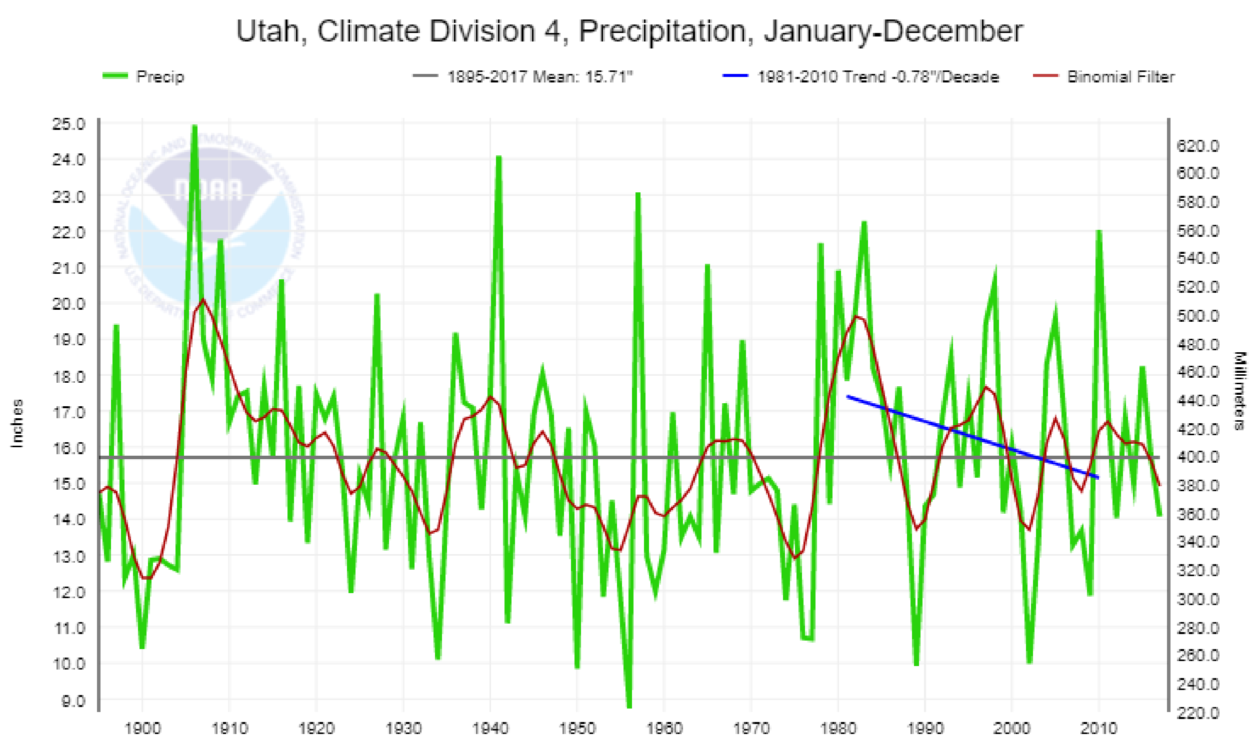


Figure 18, Utah Northern Mountains Climate Division 5 Precipitation Trend

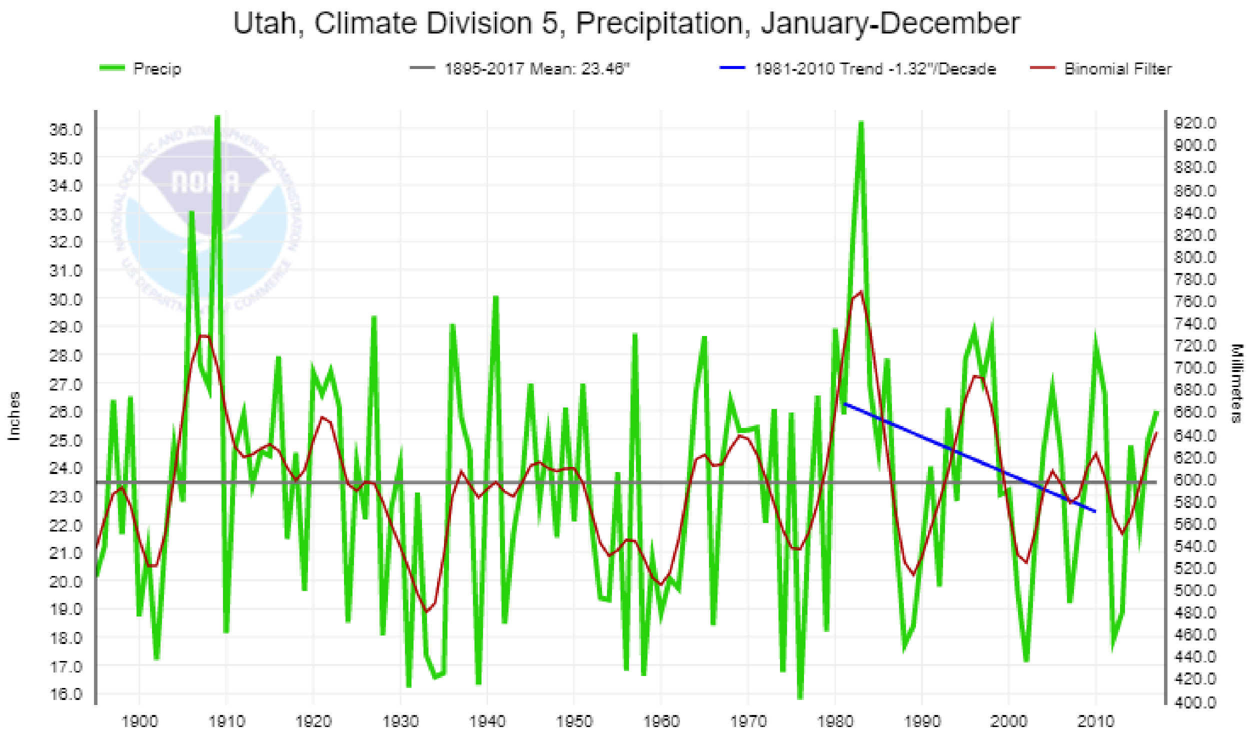


Figure 19, Utah Uinta Basin Climate Division 6 Precipitation Trend

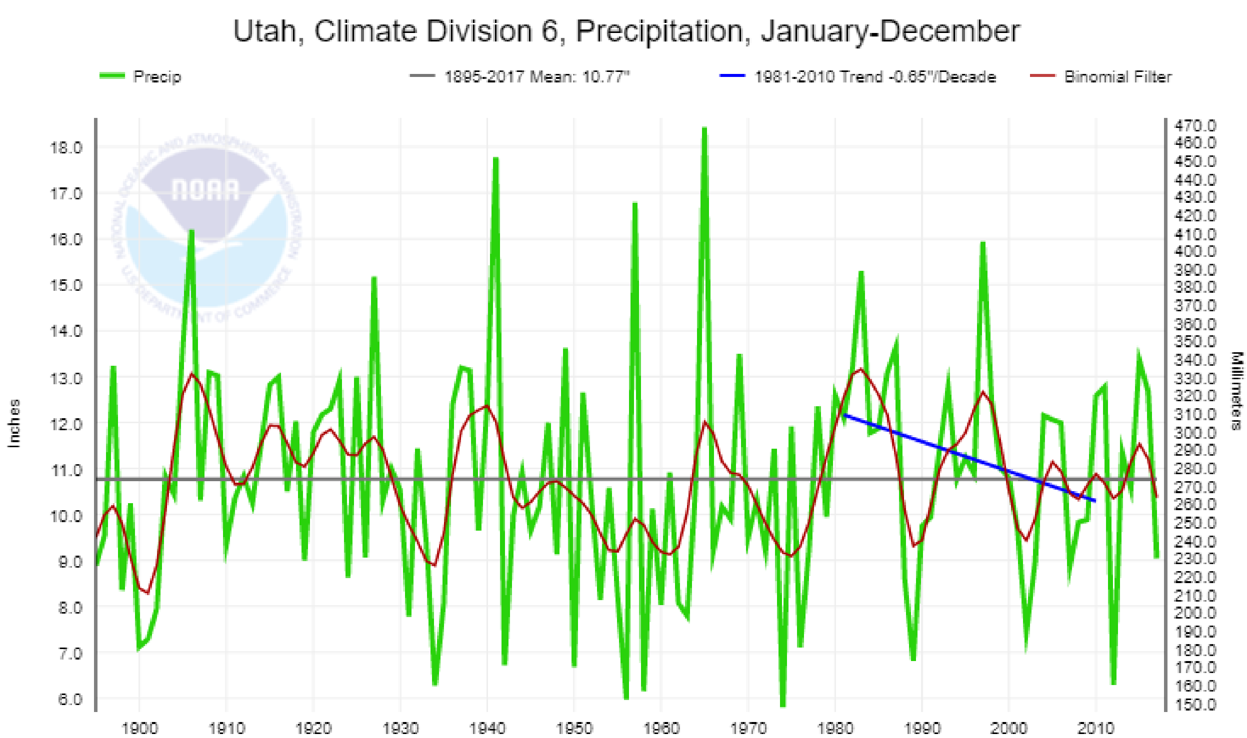


Figure 20, Utah Southeast Climate Division 7 Precipitation Trend

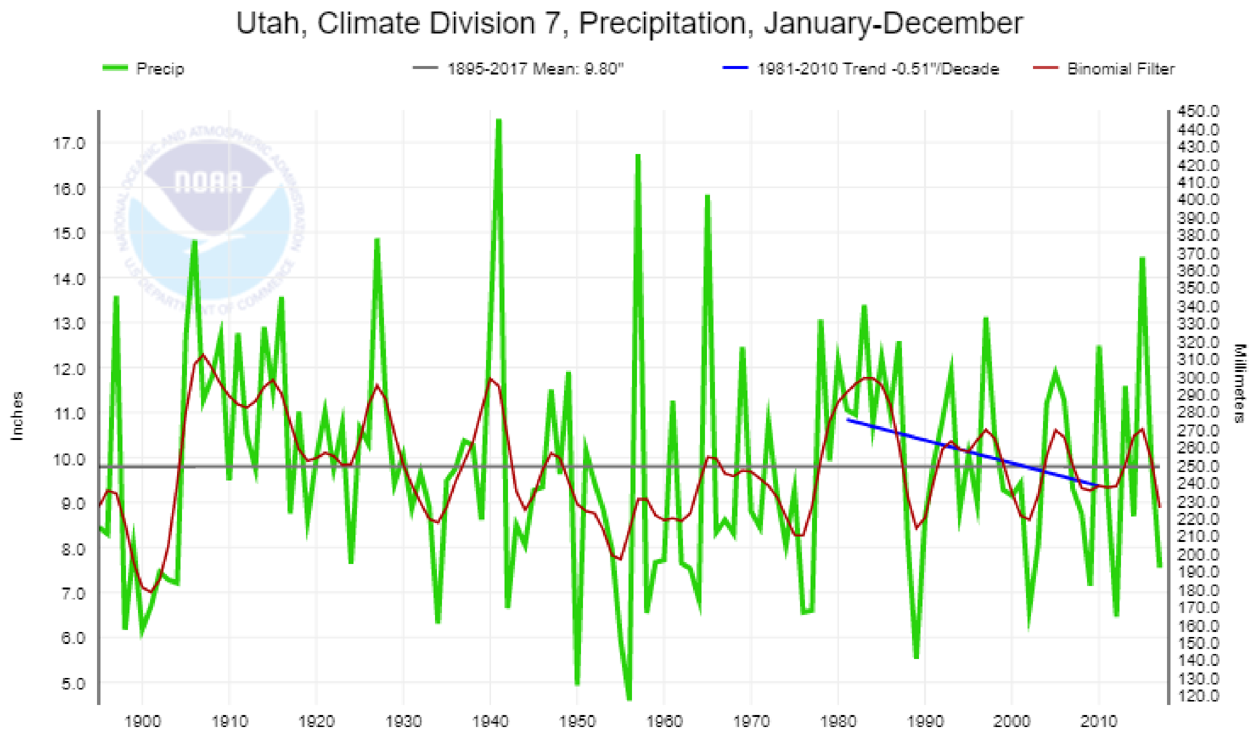


Figure 21, Utah Western Climate Division 1 Temperature Trend

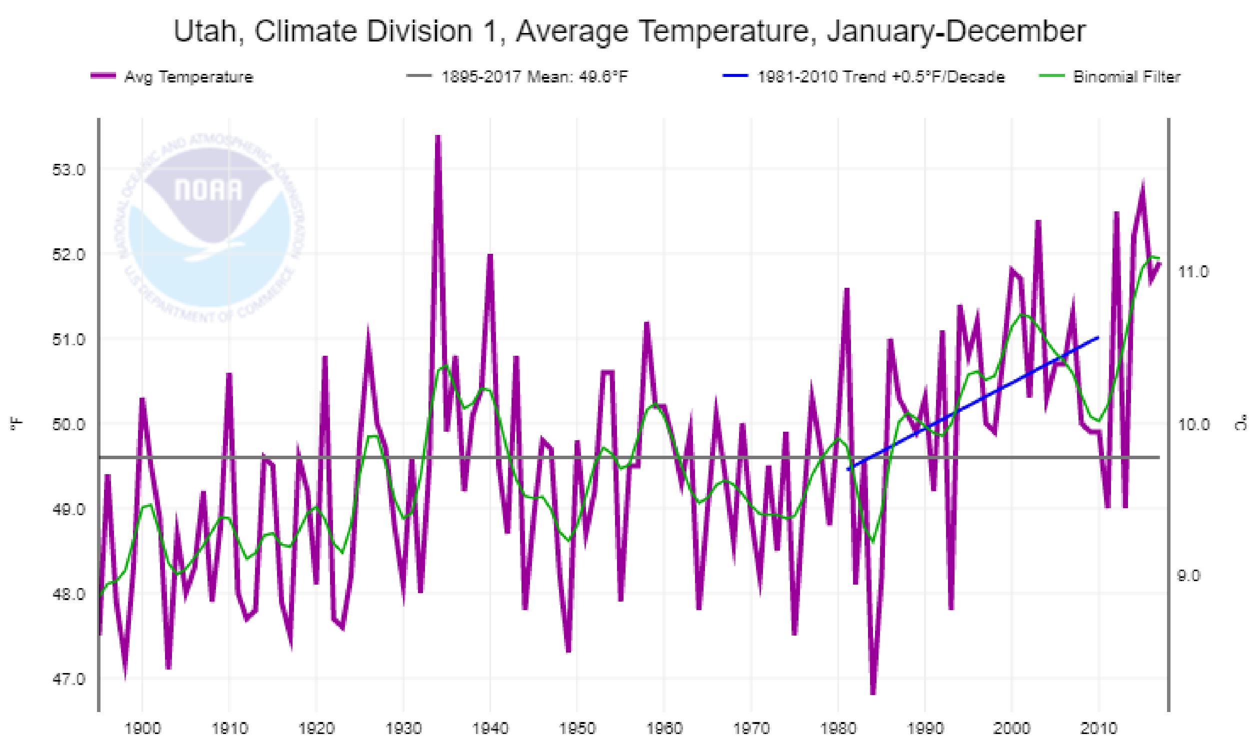


Figure 22, Utah Dixie Climate Division 2 Temperature Trend

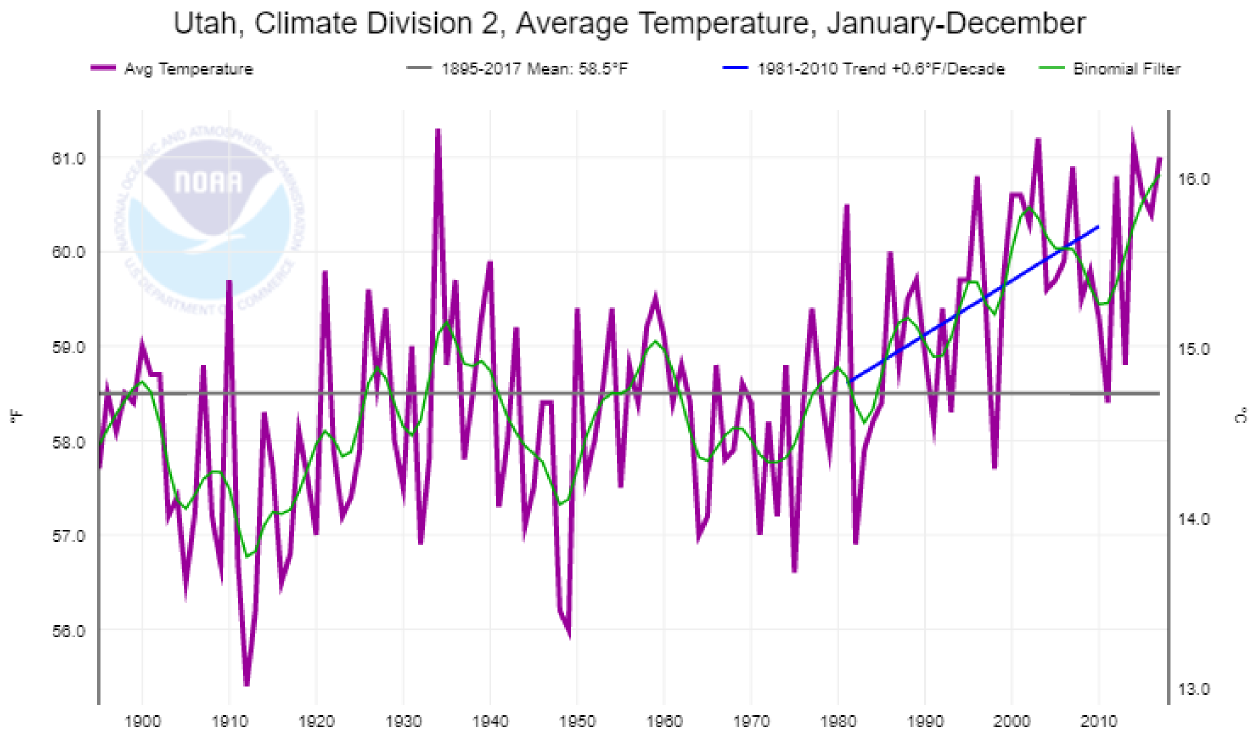


Figure 23, Utah North Central Climate Division 3 Temperature Trend

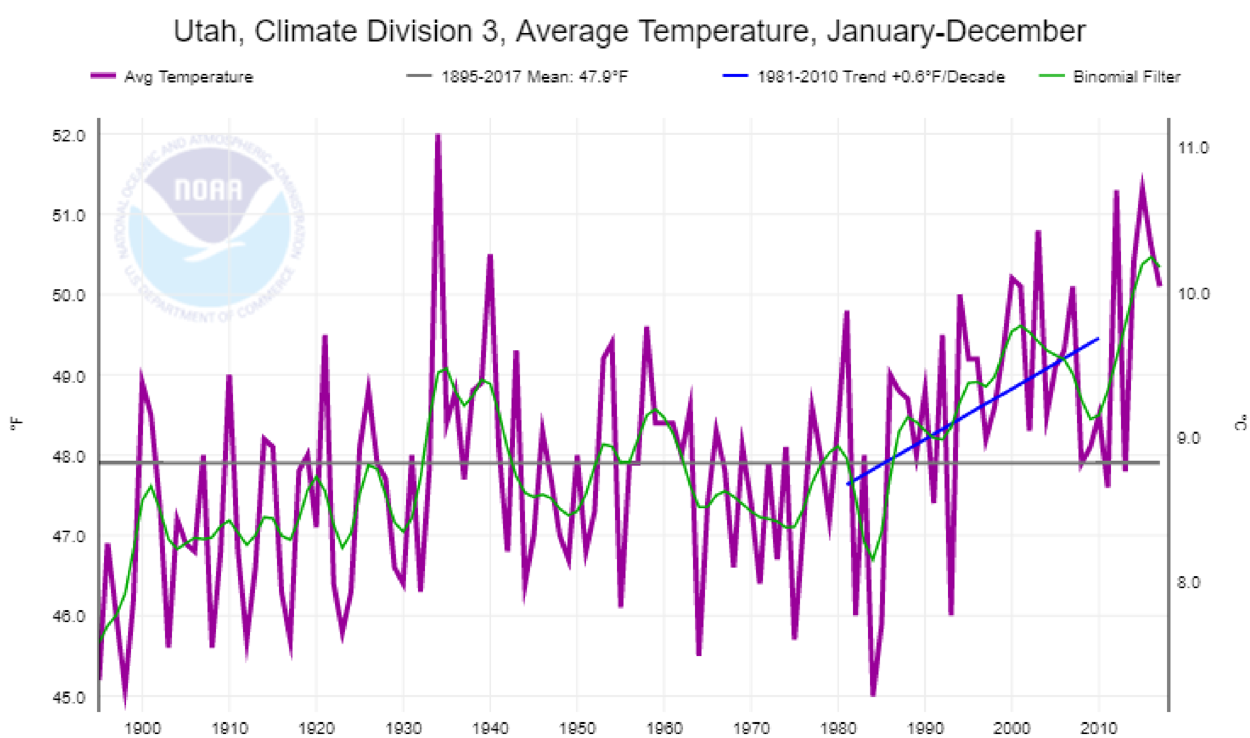


Figure 24, Utah South Central Climate Division 4 Temperature Trend

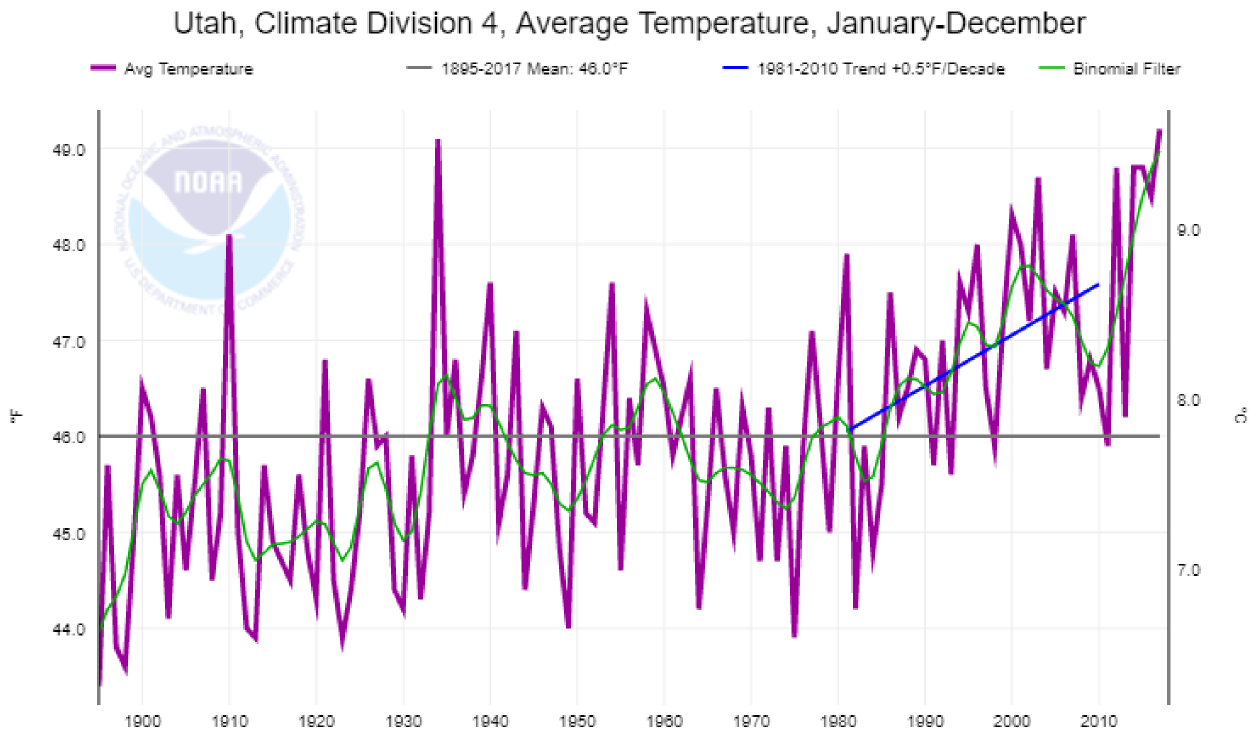


Figure 25, Utah Northern Mountains Climate Division 5 Temperature Trend

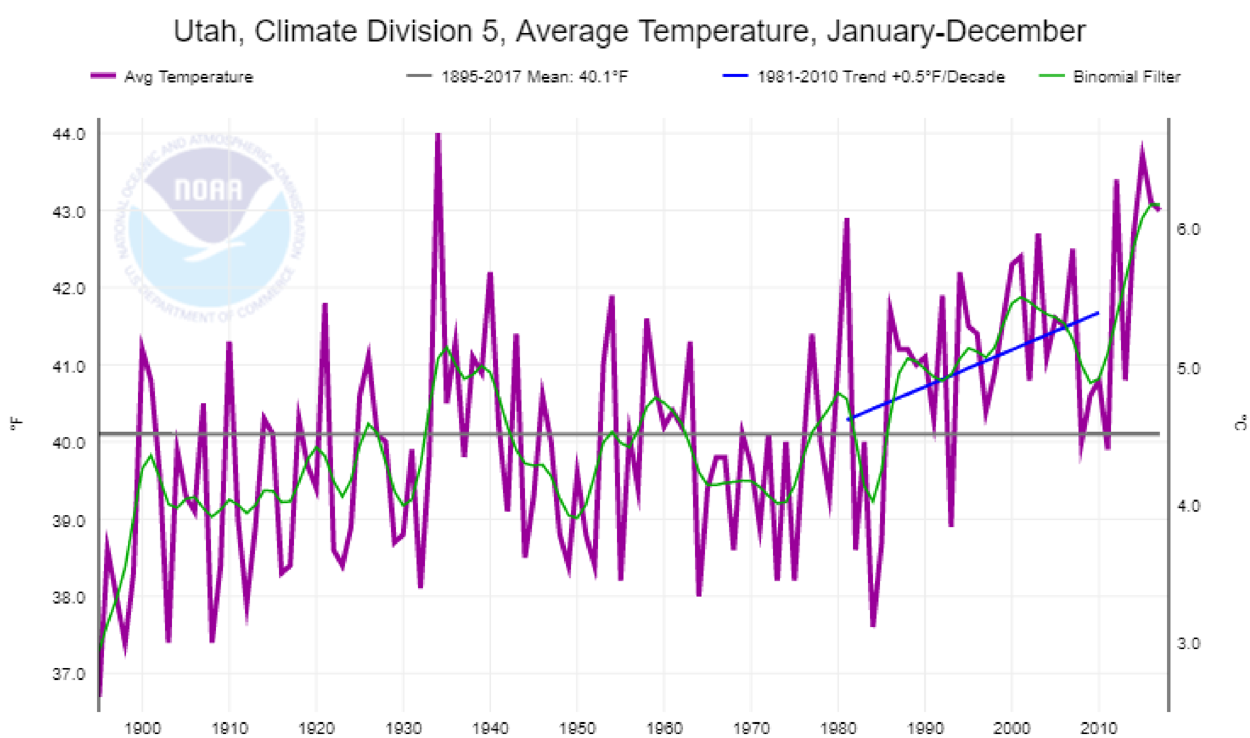


Figure 26, Utah Uinta Basin Climate Division 6 Temperature Trend

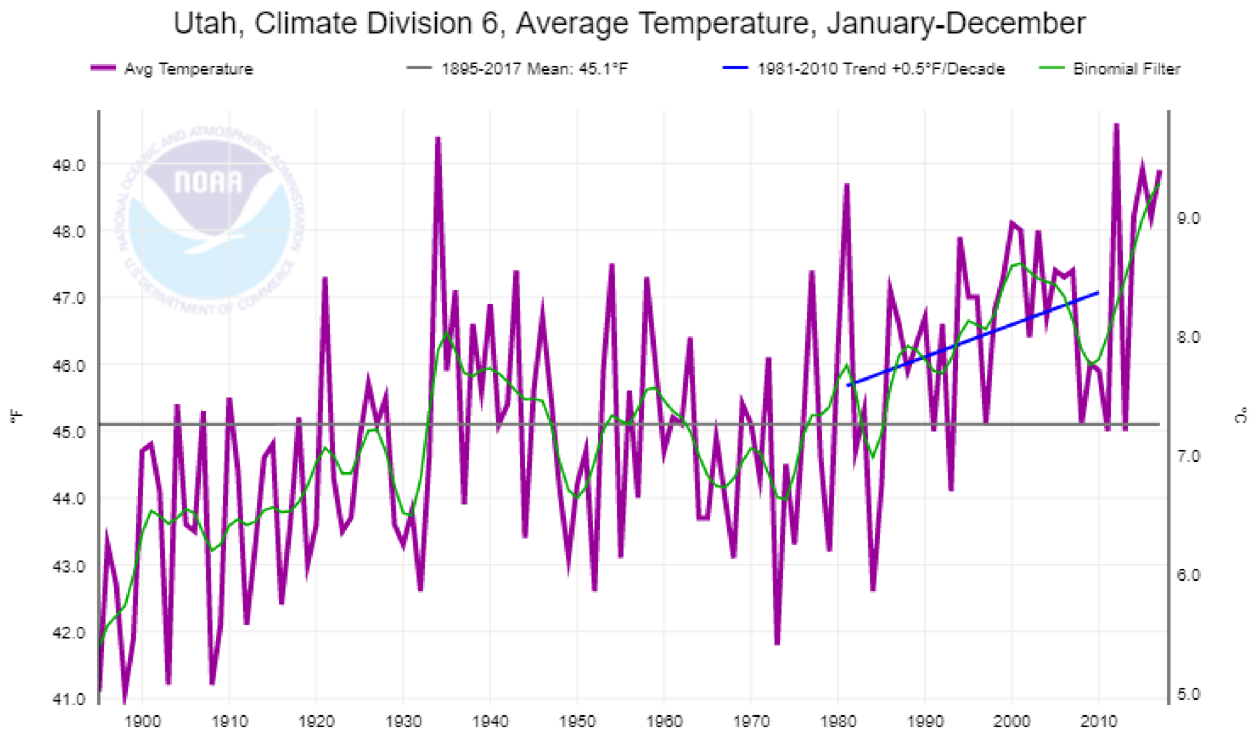
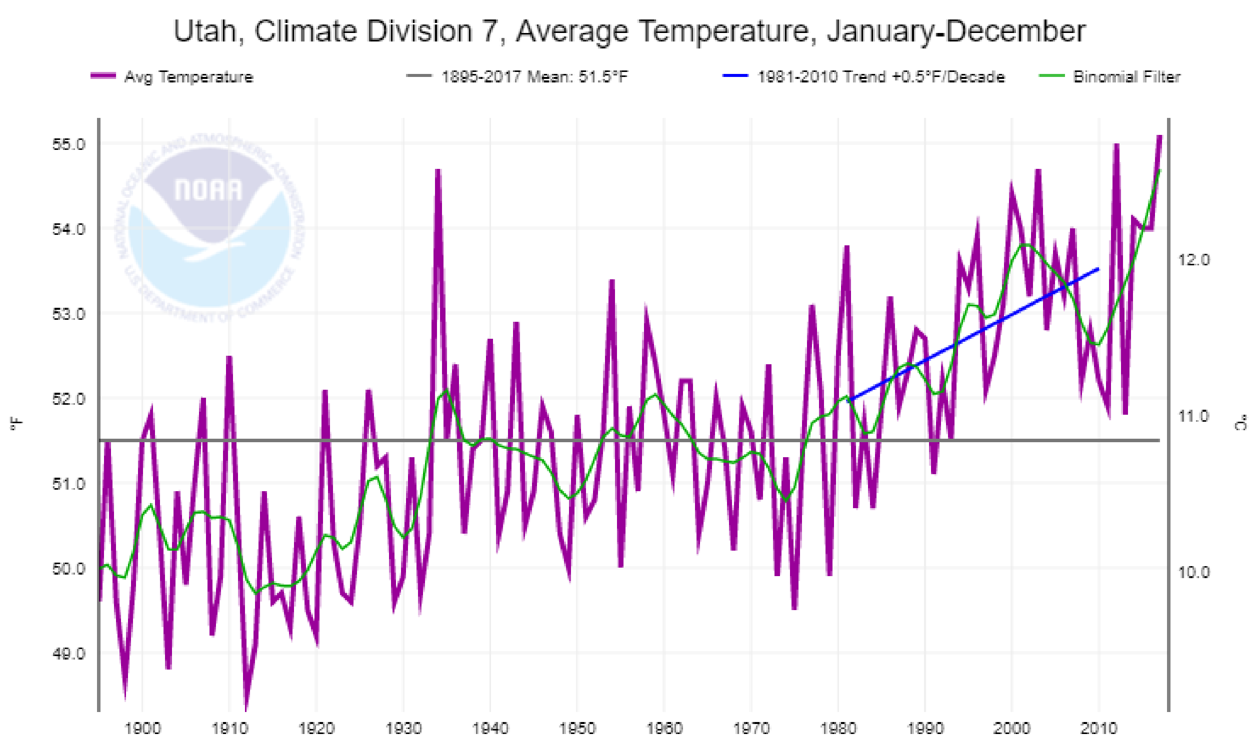


Figure 27, Utah Southeast Climate Division 7 Temperature Trend



4.2.3. Climate Projections

Fourth National Climate Assessment – Southwest Region

In November 2018 the Fourth National Climate Assessment (NCA4) Volume II was published. The NCA4 was written to help inform decision makers, utility and natural resource managers, public health officials, emergency planners, and other stakeholders by providing a thorough examination of the effects of climate change in the United States (USGCRP, 2018). The National Oceanic and Atmospheric Administration (NOAA) summarizes some of the key findings of the report by stating that the US is increasingly vulnerable to climate change and while societal responses to climate change have expanded they are not yet at the scale needed to avoid substantial impacts (NOAA, 2018). Compared to previous reports, NCA4 provides greater detail on regional scales as impacts and adaptation tend to be realized at a more local level.

The Southwest region (Arizona, California, Colorado, New Mexico, Nevada, and Utah) encompasses diverse ecosystems, cultures, and economies, reflecting a broad range of climate conditions, including the hottest and driest climate in the United States. The average annual temperature of the Southwest increased 1.6°F (0.9ºC) between 1901 and 2016. Moreover, the region recorded more warm nights and fewer cold nights between 1990 and 2016, including an increase of 4.1°F (2.3°C) for the coldest day of the year. Each NCA has consistently identified drought, water shortages, and loss of ecosystem integrity as major challenges that the Southwest confronts under climate change. Since the last assessment, published field research has provided even stronger detection of hydrological drought, tree death, wildfire increases, sea level rise, and warming, oxygen loss, and acidification of the ocean that have been statistically different from natural variation, with much of the attribution pointing to human-caused climate change (USGCRP, 2018).

Colorado Plateau Rapid Ecoregional Assessment (REA)

The BLM prepared the Colorado Plateau Rapid Ecoregional Assessment (CPREA) to predict future conditions for the Colorado Plateau including climate change (see section V of the CPREA report (Bryce, 2012). The cumulative effect area is the Colorado Plateau, including areas of Utah east of the Wasatch Mountains and south of the Uinta Mountains, from 1968 to 2060 which were the years included in the analysis. Past, present, and reasonably foreseeable activities include energy development, agricultural development, urban and road development, and recreation development. The assumption details are incorporated by reference, the CPREA depicts the data sources for potential oil and gas leasing, development, and production, and oil shale and tar sand extraction. Modeled average annual future temperatures in the CPREA are general predicted to increase. Average annual precipitation predicted by the model in general are predicted to decrease (drier) through 2030 and increase (wetter) through 2060. Potential for climate related change in Colorado Plateau area generally predicted to be mostly moderate or lower, with higher potentials for change in higher elevations. Field offices within the CPREA area include Kanab, Moab, Monticello, Price, Richfield, and Vernal, as well both the Grand Staircase Escalante and Bear Ears National Monuments.

Central Basin and Range Rapid Ecoregional Assessment (REA)

In addition to the CPREA, the BLM prepared the Central Basin and Range Rapid Ecoregional Assessment (CBRREA) (Comer, 2013). The area of interest covers most of the Great Basin, including the western half of Utah. The CBRREA used an ensemble mean from 6 global climate models to determine future climate change projections in the Central Basin and Range area. The report discusses climate change projections. Results for precipitation suggest there is no strong trend toward either wetter or drier conditions in any month for the Central Basin. With the exception of a slight increase in summer “monsoon” rains toward the south and east, there are no significant forecasted trends in precipitation for any other months in either the near term (2020s) or midcentury (2050s) time slices. The CBRREA projected changes to temperature by 2060 by showing areas where the count of the monthly maximum and minimum temperatures deviate by two standard deviations or more from the baseline 20th century mean temperature. From this, areas can be identified where concentrated climate change or lack of climate change is projected to occur. In general, temperatures are projected to increase, with mountainous areas expected to see the most change. Potential impacts to individual resources from projected climate change are further described in the CBRREA (Comer, 2013). Field offices within the CBRREA area include Cedar City, Fillmore, St. George, and Salt Lake.

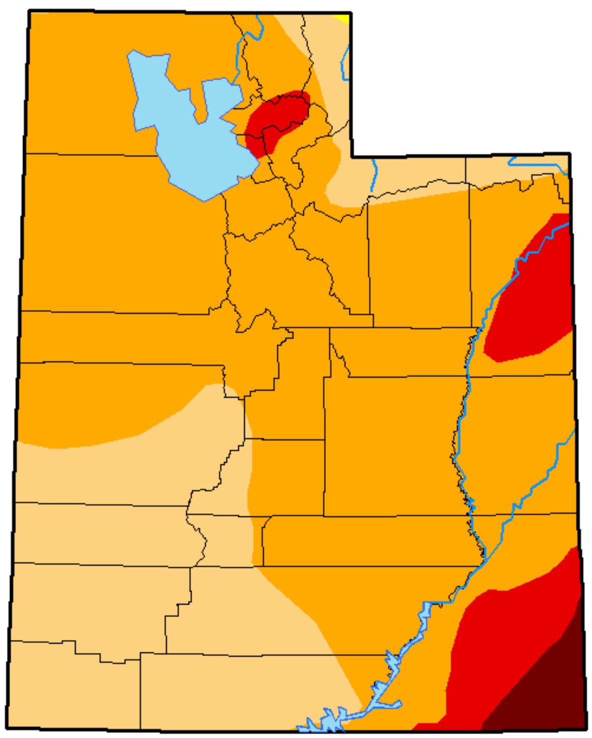
4.2.4. Drought

Utah drought conditions as of December 2018 are shown in Figure 28 (National Drought Mitigation Center, 2018). Most of Utah is experiencing moderate or worse drought conditions. Portions of Cache, Davis, Morgan, Rich, San Juan, Weber, and Uintah counties have extreme drought conditions. While San Juan County is experiencing exceptional drought conditions in the Four Corners region. The seasonal outlook is for drought to persist across Utah (Figure 29). Temperature outlook from January 2019 through February 2020 is expected to be above normal (Figure 30). The precipitation outlook from January 2019 through February 2020 is expected to have equal chance of being above or below normal for most of the state, with above normal chance for the southeast part of Utah for the first four months of 2019 (Figure 31). As the drought monitor is only a snapshot of current and recent past condition, historical precipitation trend information is also provided in Appendix A (Cedar City Field Office) through Appendix J (Vernal Field Office).

Figure 28, Drought Conditions in Utah

U.S. Drought Monitor

Utah



December 4, 2018

(Released Thursday, Dec. 6, 2018)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	99.96	73.33	8.44	1.83
Last Week *11-27-2018*	0.00	100.00	99.96	76.10	17.79	3.01
3 Months Ago *09-04-2018*	0.00	100.00	99.96	73.48	37.33	7.24
Start of Calendar Year *01-02-2018*	9.73	90.27	61.37	19.64	0.00	0.00
Start of Water Year *09-25-2018*	0.00	100.00	99.96	87.58	46.68	7.24
One Year Ago *12-05-2017*	15.33	84.67	53.40	0.00	0.00	0.00

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Deborah Bathke
National Drought Mitigation Center

http://droughtmonitor.unl.edu/

Figure 29, Seasonal Drought Outlook

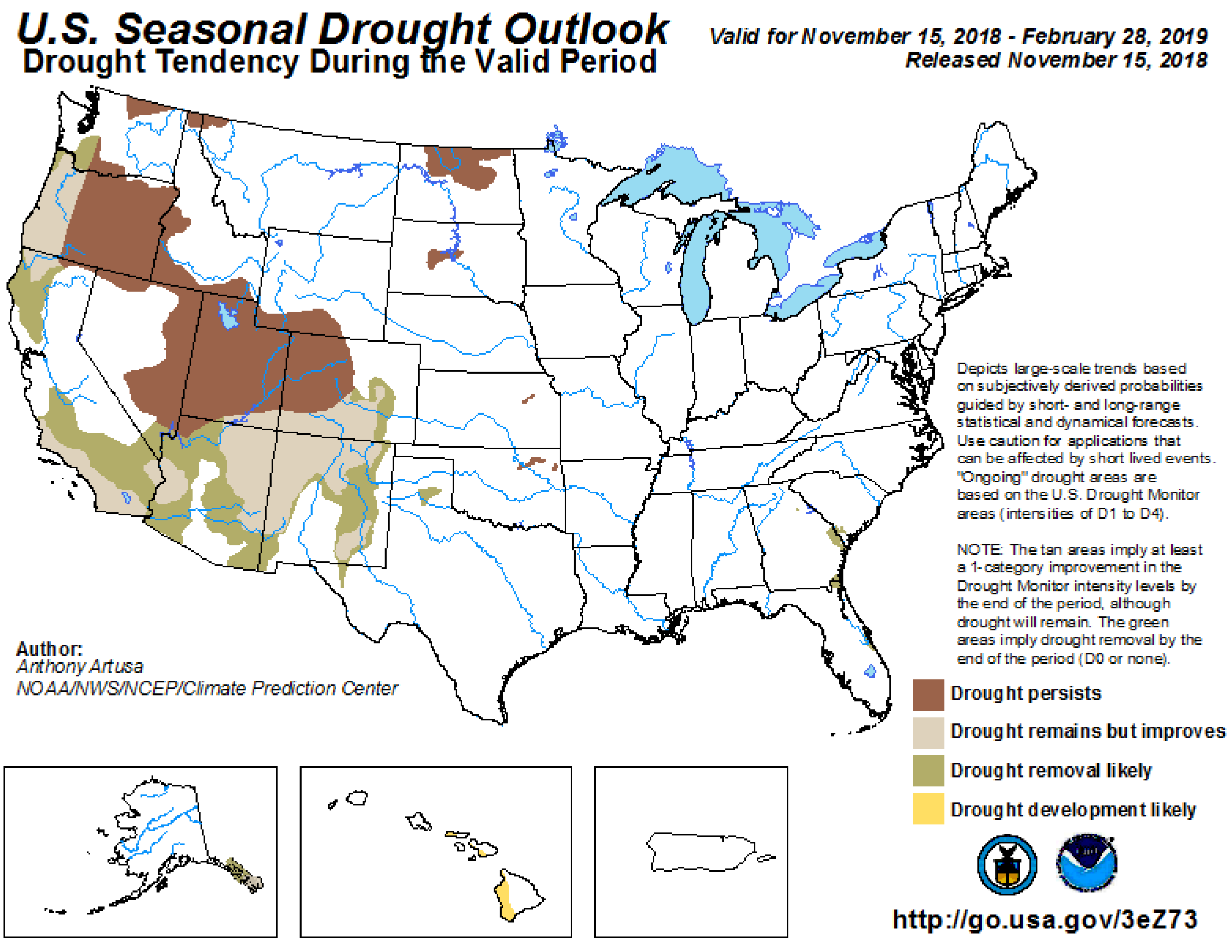


Figure 30, Temperature Outlook from January 2019 to February 2020

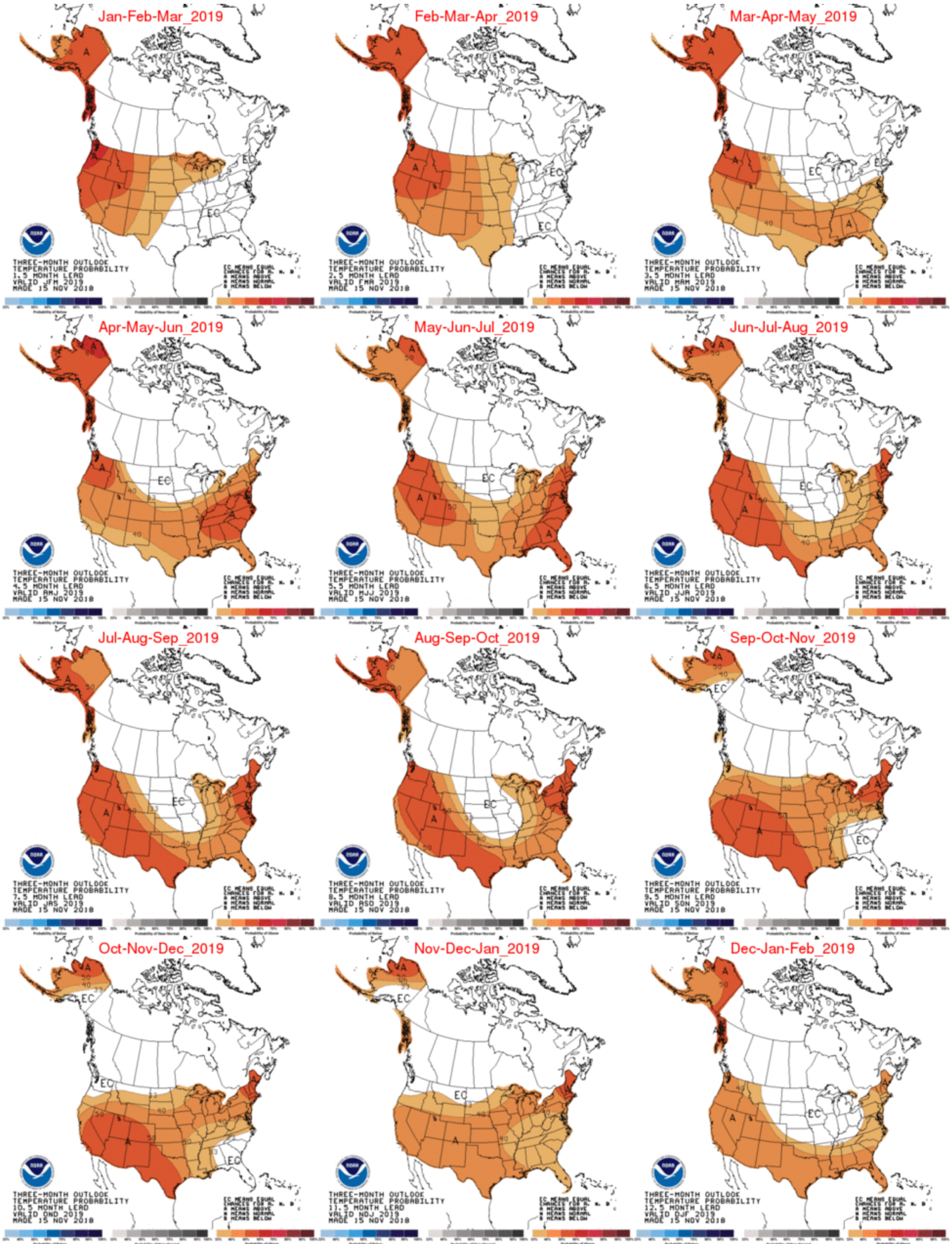
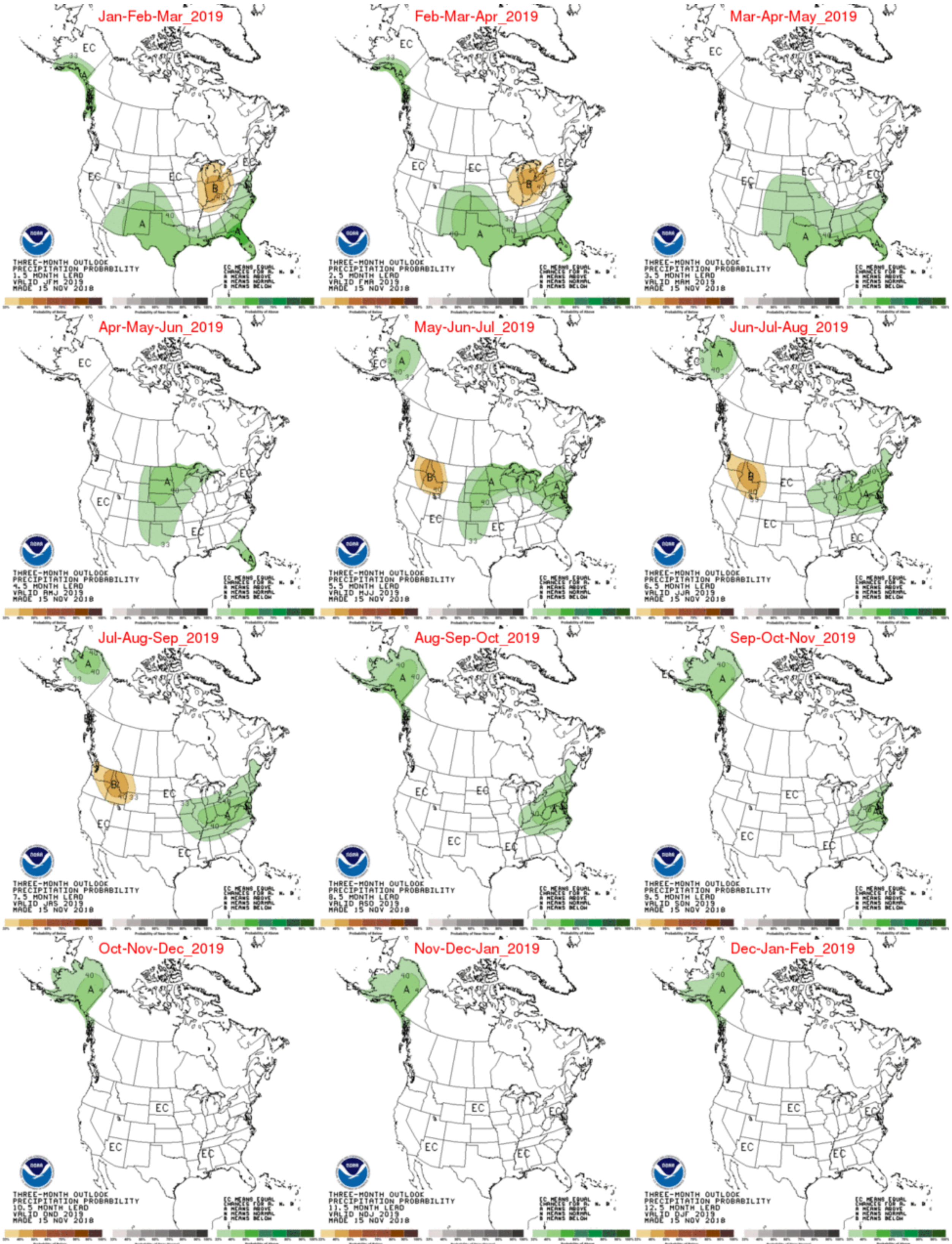


Figure 31, Precipitation Outlook from January 2019 to February 2020



4.2.5. Greenhouse Gas Emissions

Current ongoing global climate change is caused, in part, by the atmospheric buildup of greenhouse gases (GHGs), which may persist for decades or even centuries. The buildup of GHGs such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases since the start of the industrial revolution has substantially increased atmospheric concentrations of these compounds compared to background levels.

Each GHG has a global warming potential (GWP) that accounts for the intensity of each GHG's heat trapping effect and its longevity in the atmosphere. GWP values allow for a comparison of the impacts of emissions and reductions of different gases. Specifically, it is a measure of how much energy the emissions of 1 ton of a gas will absorb over a given period of time, relative to the emissions of 1 ton of CO_2. According to the IPCC, GWPs typically have an uncertainty of ±35 percent. GWPs have been developed for several GHGs over different time horizons including 20 year, 100 year, and 500 year. The choice of emission metric and time horizon depends on type of application and policy context; hence, no single metric is optimal for all policy goals. The 100-year GWP (GWP100) was adopted by the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol and is now used widely as the default metric. In addition, the EPA uses the 100 year time horizon in its inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2016 (EPA, 2018), GHG Reporting Rule requirements under 40 CFR Part 98 Subpart A, and uses the GWPs and time horizon consistent with the IPCC Fifth Assessment Report (AR5), (IPCC, 2013) in its science communications. The BLM uses GWP from the IPCC AR5 to reflect the current state of science, and uses the 100 year time horizon and values without carbon feedback to be consistent with UNFCCC and the EPA. Table 11 lists the GPWs from the IPCC AR5. When possible the BLM reports emissions of each GHG so others can calculate using different time horizons or if GWP values are updated.

Table 11 Greenhouse Gases and Their Global Warming Potentials

Pollutant	Carbon Dioxide (CO_2)	Methane (CH_4)	Nitrous Oxide (N_2O)	Hydrofluorocarbons (HFCs)	Perfluorocarbons (PFCs)	Sulfur hexafluoride (SF_6)
GWP	1	28-36	265-295	Up to 12,400	6,630-11,100	23,500

Source: IPCC AR5 (IPCC, 2013)

It is important to note that GHGs will have a sustained climatic impact over different temporal scales due to their differences in global warming potential (described above) and lifespans in the atmosphere. For example, methane has an average atmospheric life time of 12 years. Carbon dioxide's lifetime cannot be represented with a single value because the gas is not destroyed over time, but instead moves among different parts of the ocean-atmosphere-land system. Some carbon dioxide may be absorbed quickly while some will remain in the atmosphere for thousands of years (EPA, 2018).

Global Emissions and BLM Contributing Activities

Because GHGs circulate freely throughout Earth's atmosphere, climate change is a cumulative global issue. The largest component of global anthropogenic GHG emissions is CO_2. The largest contributors of GHG's, primarily CO_2 and CH_4, from BLM activities derive from oil and gas production, solid mineral (including coal) mining, and livestock grazing. CO_2 is directly emitted through combustion during use of heavy equipment and machines. Fugitive emissions of CH_4 occur from oil and gas production and coal mining and is also produced through enteric fermentation from livestock. However, the largest contribution of BLM related GHG's is the indirect production of CO_2 due to combustion of fossil fuels produced from federally owned lands. As such, recent court decisions require the BLM to disclose estimates of the amount of GHGs released through these "downstream emissions."

For context, BLM related emissions can be compared with state, national, and global total GHG emissions in Table 12. Sources of GHG emissions include the EPA's GHG Reporting Program FLIGHT tool (EPA, 2018) for state emission, the EPA inventory report on GHG emissions and sinks (EPA, 2018) for national emissions, and the Joint Research Centre CO_2 & GHG Emission of All World Countries (Janssens-Maenhout, et al., 2017) for global emissions.

In 2016, total gross U.S. greenhouse gas emissions were 6,511.3 million metric tons (MMT) of CO_2e. Total U.S. emissions have increased by 2.4 percent from 1990 to 2016, and emissions decreased from 2015 to 2016 by 1.9 percent (126.8 MMT CO_2 Eq.). The decrease in total greenhouse gas emissions between 2015 and 2016 was driven in large part by a decrease in CO_2 emissions from fossil fuel combustion. The decrease in CO_2 emissions from fossil fuel combustion was a result of multiple factors, including: (1) substitution from coal to natural gas and other non-fossil energy sources in the electric power sector; and (2) warmer winter conditions in 2016 resulting in a decreased demand for heating fuel in the residential and commercial sectors (EPA, 2018).

Table 12, GHG Emission in Million Metric Tons (CO_2e)

Utah	US Fossil Fuel Combustion	United States	Global
36.0	4,966.0	6,511.3	46,423.3

Source: Inventory of US Greenhouse Gases Emission and Sinks (EPA, 2018)
EPA GHG Reporting Program (EPA, 2018)
Fossil CO2 & GHG Emissions of all World Countries, recent year 2012 (Janssens-Maenhout, et al., 2017)

GHG reported emissions from major sources in Utah in 2016 totaled 36.0 million Metric Tons of CO_2e. A total of 66 facilities reported GHG emissions in 19 of Utah's 29 counties.

Downstream Fossil Fuel Combustion Emissions

Many BLM decisions regarding oil, gas, and coal development may result in indirect downstream combustion of the fossil fuel. While the BLM does not exercise control over the specific end use of fossil fuels it is reasonable to assume that some if not all of extracted minerals from a project may be combusted for energy and heating. Estimates of downstream emissions can be made using publically available emission factors and production estimates of fossil fuels.

Production estimates of coal may be determined from reasonable foreseeable development scenarios or state permitted annual production for a facility. Estimates for oil and gas production are more difficult as the amount of minerals can be highly variable from one well to the next.

Factors such as life expectancy of a well, production decline, and geology can determine if a well is high or low producing. As these factors are difficult to predict, it is assumed that future production will be similar to recent historical production. Historical oil and gas production and number of active wells for each county in Utah is found in the Utah Division of Oil Gas and Mining (UDOGM, 2018) monthly production reports. The December report lists the total production and active wells for the year. County level average production for each field office is presented in Appendix A (Cedar City Field Office) through Appendix J (Vernal Field Office). Statewide average annual production is listed in Table 13 below. On a county level the UDOGM monthly report only lists the total number of active wells, so estimated downstream GHG emissions using county level information should be based on total oil and gas production. For lease sales in counties without recent production data the statewide average may be used and downstream GHG emissions should be calculated separately for oil and gas wells since the UDOGM report identifies the number of oil and gas wells at the state level.

Table 13, Estimates of Statewide Well Production and GHG Combustion Emissions

	Produced Oil (bbl)	Produced Gas (mcf)	# of Oil Wells	# of Gas Wells	Produced Oil per Well	Produced Gas per Well	MT CO_2e Oil	MT CO_2e Gas
Utah	30,417,687	430,301,754	4176	6607	7,283	65,133	3132	3589

Data source - https://oilgas.ogm.utah.gov/oilgasweb/publications/monthly-rpts-by-cnty.xhtml

Annual oil and gas production averaged over the last ten years (2008-2017)

Producing wells is determined by averaging the number of producing wells over the last ten year (2008-2017).

Oil well GHG indirect emission factor: 0.43 MT CO2e per barrel (EPA, 2018)

Gas well GHG indirect emission factor are averaged from: 0.0551 MT CO2e per million cubic feet (EPA, 2018)

There is some uncertainty in estimates of oil and gas production and ultimately downstream GHG emission estimates. Production can vary by well and from one year to the next. To better understand the range of potential downstream GHG emissions the standard deviation of annual productions is calculated from 2008 to 2017. Statistically, one standard deviation will include about 68% of the wells used to calculate the mean and two standard deviations will cover 95%. Statewide the standard deviation in production for a single oil and gas well is 1,534 bbl/yr and 7,968 mcf/yr respectively. This results in ±659 MT CO_2e/yr for an oil well and ±439 MT CO_2e/yr for a gas well from one standard deviation of annual production in Utah.

To express these emissions in ways relatable to everyday life the EPA GHG equivalency calculator is used (EPA, 2018). Emissions from an average producing oil well in Utah is equivalent to 671 passenger vehicles driven for one year or energy use for 338 homes in one year. For a single gas well emissions are equivalent to 767 vehicles or 387 homes.

Past and Present Cumulative Emissions from Federal Fossil Fuel Extraction and Combustion

The U.S. Geological Survey (USGS) estimated GHG emissions resulting from the extraction and end-use combustion of fossil fuels produced on Federal lands in the United States (USGS, 2018). The study reports emissions from both the combustion of fuel and fugitives from extraction and transport over a ten year period (2005-2014). In 2014 Federal land fossil fuels produced emissions of 1,279.0 million metric tons (MMT) CO_2, 47.6 MMT CO_2e of CH_4, and 5.5 MMT CO_2e for N_2O. Emissions from Federal lands account for 23.7% for CO_2, 7.3% for CH_4, and 1.5% for N_2O of nationwide fossil fuel emission totals over the ten year period. In Utah, Federal fossil fuel GHG emissions from extraction and combustion was 43.1 MMT CO_2e, or about 3.4% of national Federal fossil fuel emissions in 2014. Methane emissions in the same year were 3.5 MMT CO_2e or 7% of national Federal emissions. Uncertainty associated with emission estimates are between 2-5% for combustion, 25-42% for fugitives, and between 12-15% for degassed CH_4 emissions from coal mines.

Carbon Sequestration

Federal lands are important for carbon sequestration. The USGQ estimates that federal lands sequestered 83,600 MMT CO_2e in 2014, a 1.6% increases since 2015 (USGS, 2018). Soils store 63% of the carbon, vegetation 26%, and dead organic material 11%. The national rate of net carbon uptake (sequestration) varies from 475 MMT CO_2e/yr to a source (emission) of 51 MMT CO_2e due to changes in climate/weather, land use, land cover change, wild fire frequency, and other factors. Terrestrial ecosystems on Federal lands sequester an average of 195 MMT CO_2e/yr national between 2005 and 2014, offsetting about 15% of emissions resulting from fossil fuel extraction and combustion nationally. In Utah, the annual average ecosystem stock is 3,581 MMT CO_2e, with soils accounting for about 70%. The annual average sequestration in Utah is 8.6 MMT CO_2e/yr., offsetting about 20% of extraction and combustion emissions from fossil fuels produced on Federal lands in Utah.

Future Net Emissions Estimates

Historical information on GHG emissions and carbon storage from the USGS report could be used to estimate future cumulative emissions, assuming past averages and trends continue. From 2005 to 2014 the average net GHG emissions, excluding the high and low years as outliers, from Federal lands in Utah is 35.2 MMT CO_2e/yr and ranged from 14.4 to 55.0 MMT CO_2e/yr. Nationally, excluding offshore and Hawaii, average annual emissions is 950.0 MMT CO_2e/yr with a range of 759.0 to 1,151.4 MMT CO_2e/yr (USGS, 2018). Future cumulative GHG emissions are assumed to be similar to these historical averages over the near term, with indirect emissions from current oil and gas leasing and other BLM fossil fuel actions making up a portion of the total state and national emissions.

5. BLM Monitoring Activities

At times BLM Utah conducts targeted air monitoring to evaluate on-the-ground air resource conditions as needed and when funding allows. Existing air monitoring networks don't always adequately cover areas managed by the BLM and short term targeted monitoring may assist in land management decisions for these areas. BLM does not conduct air monitoring to determine attainment status of an area under the requirements of the CAA, that being a function of the appropriate federal, state, or tribal regulatory agency. BLM Utah maintains limited portable self-contained air monitoring equipment mainly focused on particulate monitoring (PM10, 2.5), ozone monitoring, and meteorology. Currently BLM owned monitoring equipment is being evaluated to determine functionality and maintenance needs. Additionally, ozone monitors are on loan to the BLM California Bakersfield Field Office.

The BLM also utilizes cooperative agreements to monitor air resources. Two air resource cooperative agreements are currently in place with UDAQ and the Utah State University (USU) Bingham Research Center. The partnership with UDAQ is to maintain, quality assure, and audit an ozone monitoring station in Escalante Utah. This station is far from urban and industrial areas and provides a good estimate of background ozone levels in Utah. Data from the Escalante monitor is publically available on the EPA AirData webpage, and in UDAQ monitoring reports. The partnership with USU is to perform an aerial leak detection survey for oil and gas well pads in the Uinta Basin. This study compared infrared emission detection capabilities between ground based and aerial imaging. The final report for the aerial emission detection survey can be found on USU's website (USU, 2018).

6. Air Resource Developments

6.1. Nonattainment Areas (NAA)

Uinta Basin

In August 2018 the EPA designated areas of Duchesne and Uintah Counties, below 6,250 feet elevation, as marginal nonattainment for ozone. Additionally, all federal actions in NAA, including those on BLM managed lands, must comply with General Conformity Rules under the CAA to demonstrate that the action conforms to state or federal implementation plans. A one year grace period for conformity determinations is allowed for newly designated NAA, ending August 2019 for the Uinta Basin NAA. Air regulatory agencies have 36 months to meet the NAAQS or develop an implementation plan to bring the area back into compliance with the standard. With a marginal nonattainment designation, regulatory agencies are not required to develop an implementation plan. Without an implementation plan, conformity can be shown if emissions are de minimus, from an exempt source, mitigated to de minimus levels, or can be offset by emission reductions on other operations in the same nonattainment airshed.

The BLM is participating in the Uinta Basin Ozone Working Group (UBOWG) (UBOWG, 2018) which includes tribal and government decision-makers, stakeholders, and other experts. The mission of UBOWG is to bring together tribal and government decision makers, stakeholders, and experts to find solutions and help achieve attainment in the Uinta Basin.

Wasatch Front

The EPA designated areas along the Wasatch Front as nonattainment for the 2006 24-hour $PM_{2.5}$ standard on December 14, 2009. On May 10, 2017 the EPA issued a final rule (EPA, 2017) to reclassify the Salt Lake and Provo NAA from Moderate to Serious. The State has until December 31, 2019 to demonstrate attainment. More stringent measures will be employed if attainment is not demonstrated by this date. The state recently concluded a public comment period for the Serious Area $PM_{2.5}$ SIP. The BLM will need to comply with the final version of this SIP for any BLM approved or funded activities occurring in these areas in a general conformity determination.

Cache Valley

On July 17, 2018 (83 FR 33886), the EPA determined that the Logan, UT and Franklin, ID NAA has attained the 2006 primary and secondary 24-hour $PM_{2.5}$ NAAQS by the December 31, 2017 attainment date. These determinations are based upon quality-assured, quality-controlled and certified ambient air monitoring data. This clean data determination (CDD) was finalized on

October 19, 2018. The area will now be in maintenance status for the next 10 years to ensure the area will continue to meet the NAAQS standard. General conformity requirements still apply for a maintenance area. As the BLM does not manage great quantities of land in this area the CDD is expected to have little or no impact on BLM actions. The CDD shows that the State of Utah is making progress on improving $PM_{2.5}$ and progress is hopefully being made in other $PM_{2.5}$ NAA. General conformity still applies until 10 years after a CDD.

6.2. Coming Year

6.2.1. ARMS Modeling

Through a cooperative agreement with USU Bingham Research Center, the BLM is updating the ARMS photochemical modeling for oil gas development in Utah. Changes from the 2013 ARMS modeling include a larger domain size to include the Price Field Office, updated base year inputs (emissions and meteorology), updated future year emission estimates (based on UDAQ growth and decline curve) (UDAQ, 2018), and model updates. BLM has included AiRTAG on model development discussions. Model results will be used in cumulative air quality impacts analysis. The final modeling report is expected in 2020.

6.2.2. Uinta Basin General Conformity

August 2019 marks one year since the final ozone nonattainment designation for portions of the Uinta Basin and the end of the one year grace period for general conformity determinations. Beginning in August all projects needing BLM approval or funding in the Uinta Basin ozone NAA will need a general conformity applicability analysis. The state BLM air resource specialist is working with field office staff to identify sources of emissions and projects that will need an applicability analysis. In addition, the state BLM air resource specialist are in contact with the EPA to better understand how general conformity will be applied in the multi-jurisdiction airshed. Most BLM approved projects are anticipated to have de minimus emission levels (100 tpy). As identified in the applicability analysis, projects with emissions exceeding de minimus levels and are not explicitly exempt by the CAA will need a full conformity determination.

6.2.3. New Scientific Reports and Research

In 2018 a number of reports and scientific articles were published about air and climate related impacts. A list of some of the reports and articles follows:

- EPA 2016 GHG Emissions Inventory Report
- IPCC 2018 Special Report
- Fourth National Climate Assessment
- USGS Federal Land GHG Emissions and Sinks
- Bureau of Indian Affairs 1-hr NO2 Study
- UDAQ 2017 Air Monitoring Report
- Hydrocarbon Emission Detection Survey of Uinta Basin Oil and Gas Wells
- Bingham Research Center Research Productions (USU, 2019)

6.2.4. 2019 Annual Air Monitoring Report

The 2019 annual report will be in a similar format to the 2018 report. Anticipated changes to the 2019 report should include updated monitoring data and inclusion of new reports or science. In addition a sub-section will be added to the introductory section that will summarize the updates between the 2018 and 2019 report.

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Appendix A (Cedar City Field Office)

Overview

Air quality in the Cedar City Field Office area is generally good. The area is in attainment or unclassifiable for all NAAQS pollutants. AQI summary information for adjacent Garfield and Washington Counties presented in Table 4 show less than one percent of days having unhealthy air. In 2018 the Utah Department of Environmental quality deployed an air monitoring station in Cedar City for monitoring $PM_{2.5}$, Ozone and NO_2. Data from this monitoring station should allow for a more thorough analysis of air pollutants in the future. Pollutants of concern for the area are Ozone and $PM_{2.5}$ since these are the pollutants that determined the AQI over the last three years in adjacent counties.

Air Quality Index

No air quality index data is available for Beaver and Iron Counties.

County CAP Emissions

Table 14 below lists the 2014 emissions inventory of CAP by source for counties within the Cedar City field office boundaries.

Table 14, 2014 Criteria Air Pollutant Emissions (tpy) by Source for the Cedar City FO

County	Source	CO	NOx	PM10	PM2.5	SOx	VOCs
Beaver	Area Sources	359.29	228.91	2,273.69	353.08	5.79	124.34
	Area Sources Oil and Gas	0.00	0.00	0.00	0.00	0.00	0.00
	Non-Road Mobile	299.76	307.10	11.52	11.16	2.74	27.38
	On-Road Mobile	2,427.00	1,427.00	116.58	55.39	3.11	251.40
	Point Sources	45.08	103.15	97.57	26.16	2.97	7.35
	Biogenics	5,014.17	0.00	0.00	0.00	0.00	24,255.87
	Wildfires	0.00	0.00	0.00	0.00	0.00	0.00
	County Total	**8,145.30**	**2,066.16**	**2,499.36**	**445.79**	**14.61**	**24,666.34**
Iron	Area Sources	1,500.99	395.90	6,223.74	933.29	9.07	700.93
	Area Sources Oil and Gas	0.00	0.00	0.00	0.00	0.00	0.00
	Non-Road Mobile	1,919.52	577.14	35.14	33.72	6.17	335.04
	On-Road Mobile	6,382.00	3,309.00	403.97	163.96	8.67	687.30
	Point Sources	26.98	35.47	22.36	9.55	3.27	114.47
	Biogenics	6,750.61	0.00	0.00	0.00	0.00	33,694.97
	Wildfires	0.00	0.00	0.00	0.00	0.00	0.00
	County Total	**16,580.1**	**4,317.51**	**6,685.21**	**1,140.52**	**27.18**	**35,532.71**

Downstream GHG Emissions

No recent well production information is available for Beaver and Iron Counties to calculate average well production in the Cedar City Field Office. Statewide average oil well production and average gas well production (Table 13) should be used to estimate downstream GHG emissions for oil or gas well decisions in the Cedar City Field Office.

Climate Normals

The Cedar City Field Office is part of the Western and South Central climate divisions in Utah. On average the South Central division has 3-4 °F cooler temperatures and receives 6 inches more annual precipitation than the Western division, primarily due to the higher elevation. Prevailing winds are primarily from a southerly direction. Table 15 lists average seasonal temperatures for cities within the Cedar City field office boundaries, while Table 16 and Table 17 list the average maximum and minimum temperatures respectively. Average seasonal precipitation can be found in Table 18. Wind information is provided in Figure 32, Figure 33, Table 19, and Table 20.

Table 15, Average (1981-2010) Temperatures in the Cedar City FO

	Average Temperature (F)				
Location	Winter	Spring	Summer	Autumn	Annual
MILFORD	29.5	49.2	71.5	50.6	50.3
CEDAR CITY	30.3	47.5	70	49.7	49.5

Table 16, Average (1981-2010) of Maximum Temperatures in the Cedar City FO

	Maximum Temperature (F)				
Location	Winter	Spring	Summer	Autumn	Annual
MILFORD	41.8	65.2	89	66.9	65.8
CEDAR CITY	43	62.7	86.9	65.5	64.6

Table 17, Average (1981-2010) of Minimum Temperatures in the Cedar City FO

	Minimum Temperature (F)				
Location	Winter	Spring	Summer	Autumn	Annual
MILFORD	17.2	33.1	54	34.4	34.7
CEDAR CITY	17.6	32.3	53	33.9	34.3

Table 18, Average (1981-2010) Precipitation for the Cedar City FO

Location	Precipitation (in)					Snow Fall (in)				
	Winter	Spring	Summer	Autumn	Annual	Winter	Spring	Summer	Autumn	Annual
MILFORD	2.41	2.94	2.32	2.78	10.45	21.8	13	0	5.6	40.4
CEDAR CITY	2.7	3.18	2.5	2.93	11.31	24.3	14.4	0.2	8.9	47.8

Figure 32, Wind Rose for Cedar City, UT

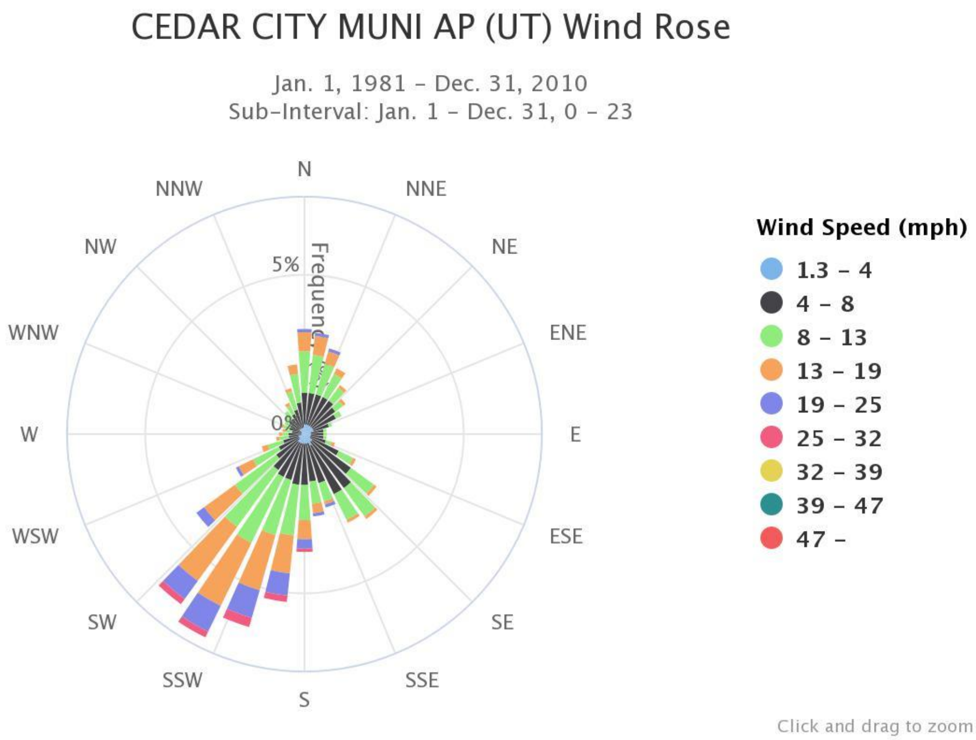


Figure 33, Wind Rose for Milford, UT

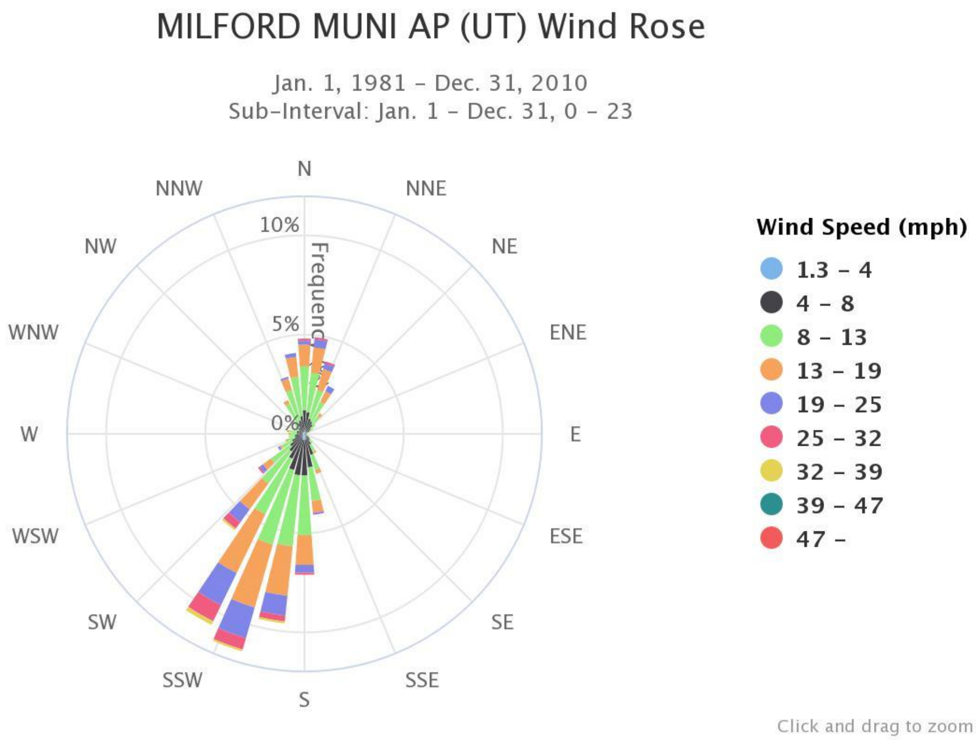


Table 19, Prevailing Wind Directions in the Cedar City FO

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
CEDAR CITY (KCDC)	SSW	SW	SSW	SSW	SSW	SSW	SW	SSW	SSW	SW	N	SSW	SSW
MILFORD (KMLF)	S	SSW	S	SSW	S	SSW	SSW	S	S	S	S	S	S

Table 20, Average Wind Speed (mph) in the Cedar City FO

STATION	Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
CEDAR CITY (KCDC)	2001-2011	5.1	5.8	7	8.6	7.5	7.9	6.8	6.9	6.7	6.2	5.9	5.5	6.6
MILFORD (KMLF)	2001-2011	8.9	9.4	10.9	12.2	10.9	11.4	10.6	11.1	10	9.6	9.5	9.7	10.3

Climate Trends

Historical yearly precipitation totals (1895-2017) and trends from the current climate normal period (1981-2010) for the Western and South Central climate divisions are shown in section 4.2.2, Figure 14 and Figure 17. Annual average temperature (1895-2017) and trends from the current climate normal period (1981-2010) are shown in Figure 21 and Figure 24 of section 4.2.2.

Appendix B (Fillmore Field Office)

Overview

Air quality in the Fillmore Field Office area is generally good. The area is in attainment or unclassifiable for all NAAQS pollutants. However, portions of the field office in Juab County are adjacent to Utah County NAAs where higher pollutant concentrations may be encountered. There are no active air monitoring stations within the Fillmore Field Office available from the EPA AirData website. Pollutants of concern are NO_2, Ozone, PM_{10}, and $PM_{2.5}$ since these are the pollutants that determined the AQI over the last three years in adjacent Utah County.

Air Quality Index

No air quality index data is available for Juab and Millard Counties.

County CAP Emissions

Table 21 below lists the 2014 emissions inventory of CAP by source for counties within the Fillmore field office boundaries.

Table 21, 2014 Criteria Air Pollutant Emissions (tpy) by Source for the Fillmore FO

County	Source	CO	NOx	PM10	PM2.5	SOx	VOCs
Juab	Area Sources	360.67	488.91	2,668.80	416.84	3.45	187.65
	Area Sources Oil and Gas	0.00	0.00	0.00	0.00	0.00	0.00
	Non-Road Mobile	781.66	399.06	19.72	18.82	3.60	210.52
	On-Road Mobile	3,049.00	1,437.00	147.03	63.06	3.91	268.40
	Point Sources	143.90	114.23	184.44	167.33	6.59	33.58
	Biogenics	5,907.63	0.00	0.00	0.00	0.00	25,717.70
	Wildfires	732.23	20.85	88.60	79.74	0.00	125.08
	County Total	**10,975.1**	**2,460.05**	**3,108.59**	**745.79**	**17.55**	**26,542.93**
Millard	Area Sources	1,179.23	938.31	5,668.22	929.65	17.29	301.69
	Area Sources Oil and Gas	0.00	0.00	0.00	0.00	0.00	0.00
	Non-Road Mobile	1,692.46	766.24	34.62	33.14	6.07	414.11
	On-Road Mobile	4,057.00	2,526.00	273.04	116.98	5.75	425.30
	Point Sources	6,538.98	24,983.82	1,998.55	1,523.41	4,422.65	79.21
	Biogenics	11,234.2	0.00	0.00	0.00	0.00	49,702.64
	Wildfires	101.16	2.88	12.24	11.02	0.00	17.28
	County Total	**24,803.0**	**29,217.3**	**7,986.67**	**2,614.20**	**4,451.8**	**50,940.23**

Downstream GHG Emissions

No recent well production information is available for Millard County and too little information is available for Juab County to calculate average well production in the Fillmore Field Office.

Statewide average oil well production and average gas well production (Table 13) should be used to estimate downstream GHG emissions for oil or gas well decisions in the Fillmore Field Office.

Climate Normals

The Fillmore Field Office is part of the Western and South Central climate divisions in Utah. On average the South Central division has 3-4 °F cooler temperatures and receives 6 inches more annual precipitation than the Western division, primarily due to the higher elevation. Prevailing winds are primarily from a southerly or northwesterly direction and are influenced by the north/south orientation of mountains in the Great Basin. Table 22 lists average seasonal temperatures for cities within the Fillmore field office boundaries, while Table 23 and Table 24 list the average maximum and minimum temperatures respectively. Average seasonal precipitation can be found in Table 25. Wind information is provided in Figure 34, Figure 35, Table 26, and Table 27.

Table 22, Average (1981-2010) Temperatures in the Fillmore FO

Location	Average Temperature (F)				
	Winter	Spring	Summer	Autumn	Annual
LITTLE SAHARA	28.1	48.1	71.8	49.8	49.5
DELTA	27.5	48.6	71.2	49.2	49.2
BLACK ROCK	30.1	50.1	70.8	50.3	50.4
FILLMORE	30.2	50	71.3	51.3	50.8

Table 23, Average (1981-2010) of Maximum Temperatures in the Fillmore FO

Location	Maximum Temperature (F)				
	Winter	Spring	Summer	Autumn	Annual
LITTLE SAHARA	40.9	63.2	89.7	66	65.1
DELTA	41.2	66	91	66.8	66.4
BLACK ROCK	43.6	68	90.3	67.9	67.6
FILLMORE	38.8	62.4	85.3	63.3	62.6

Table 24, Average (1981-2010) of Minimum Temperatures in the Fillmore FO

Location	Minimum Temperature (F)				
	Winter	Spring	Summer	Autumn	Annual
LITTLE SAHARA	15.2	33.1	54	33.5	34
DELTA	13.9	31.2	51.5	31.6	32.1
BLACK ROCK	16.6	32.1	51.3	32.6	33.2
FILLMORE	21.5	37.6	57.4	39.3	39

Table 25, Average (1981-2010) Precipitation for the Fillmore FO

Location	Precipitation (in)					Snow Fall (in)				
	Winter	Spring	Summer	Autumn	Annual	Winter	Spring	Summer	Autumn	Annual
LITTLE SAHARA	3.08	4.07	2.47	3.27	12.89	NA	NA	NA	NA	NA
DELTA	1.84	2.61	1.7	2.46	8.61	16.9	6.4	0	4.5	27.8
BLACK ROCK	1.99	2.76	2.07	2.51	9.33	20.1	7.6	0	3.8	31.5
FILLMORE	4.29	5.53	2.47	4.38	16.67	37.2	18.1	0.1	12.3	67.7

Figure 34, Wind Rose for Dugway Proving Ground

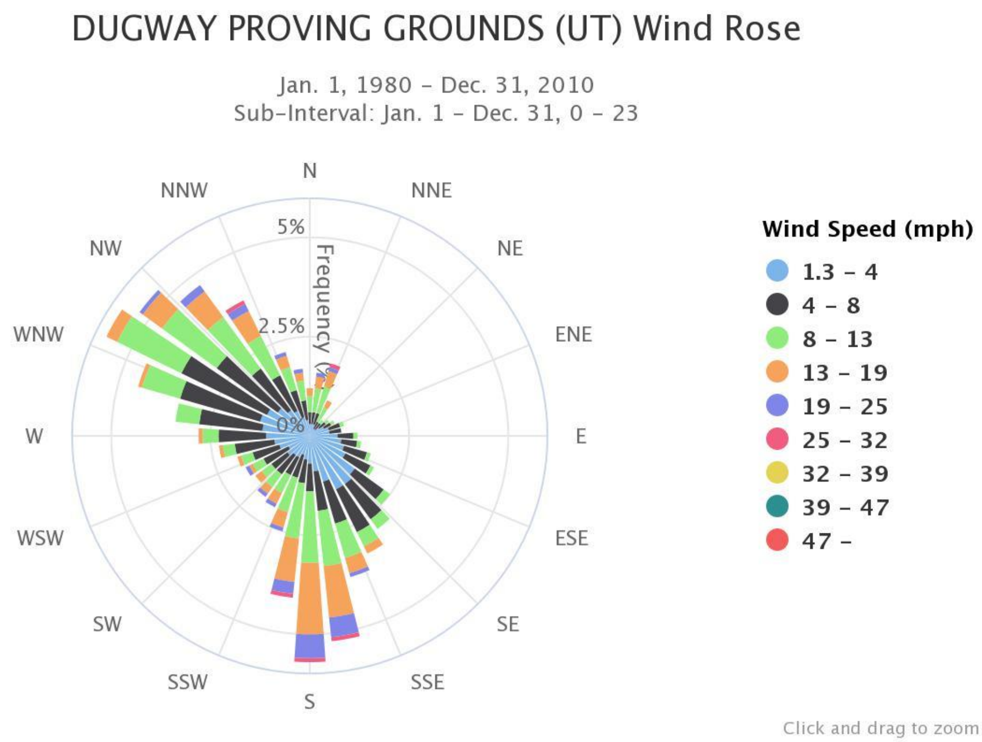


Figure 35, Wind Rose for the Milford Airport

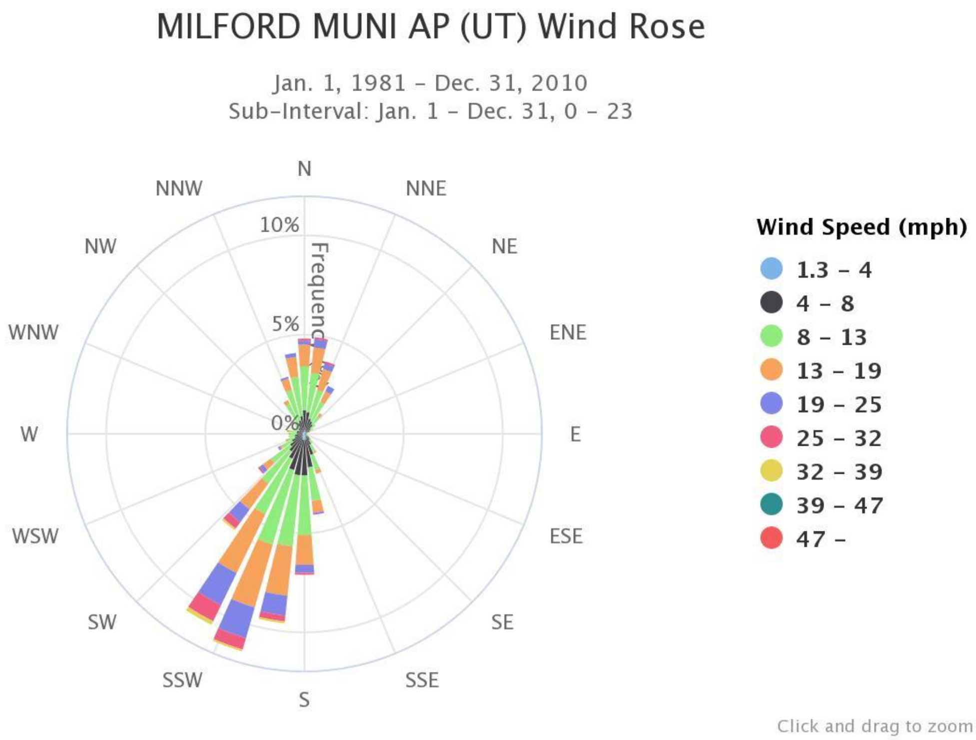


Table 26, Prevailing Wind Directions in the Fillmore FO

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
MILFORD (KMLF)	S	SSW	S	SSW	S	SSW	SSW	S	S	S	S	S	S

Table 27, Average Wind Speed (mph) in the Fillmore FO

STATION	Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
MILFORD (KMLF)	2001-2011	8.9	9.4	10.9	12.2	10.9	11.4	10.6	11.1	10	9.6	9.5	9.7	10.3

Climate Trends

Historical yearly precipitation totals (1895-2017) and trends from the current climate normal period (1981-2010) for the Western and South Central climate divisions are shown in section 4.2.2, Figure 14 and Figure 17. Annual average temperature (1895-2017) and trends from the current climate normal period (1981-2010) are shown in Figure 21 and Figure 24 of section 4.2.2.

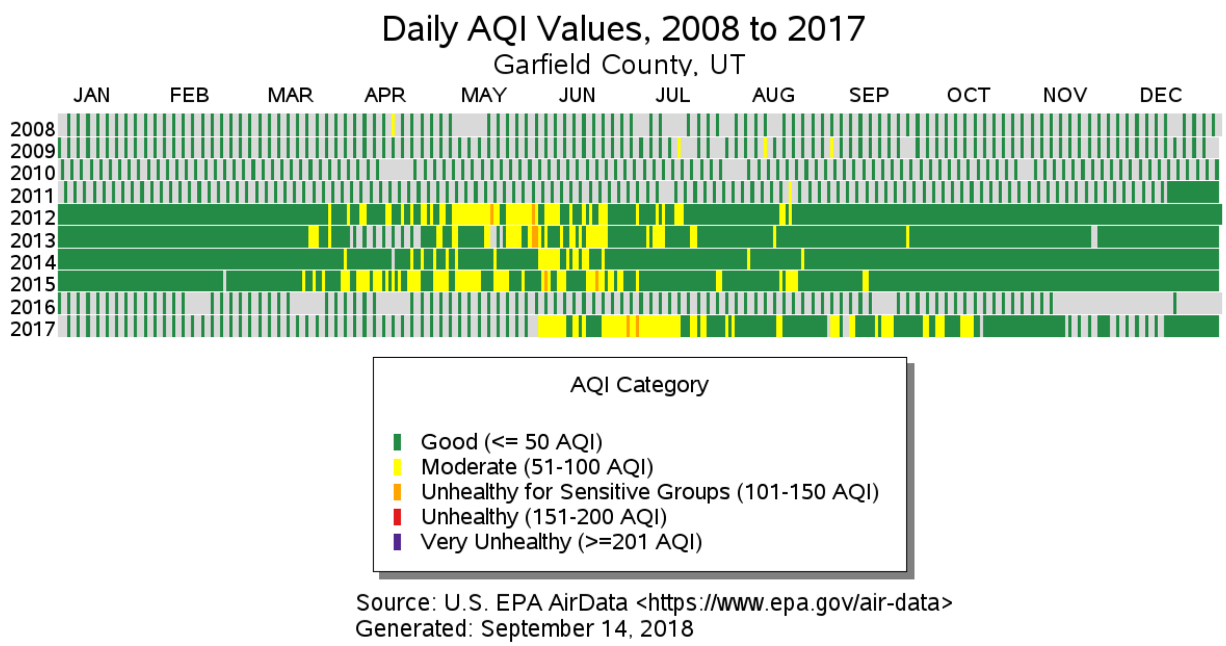
Appendix C (Kanab Field Office and Grand Staircase Escalante NM)

Overview

Air quality in the Kanab Field Office and Grand Staircase Escalante National Monument is generally good. The area is in attainment or unclassifiable for all NAAQS. AQI summary information is shown in Figure 36. In 2017, 99% of the AQI days were good to moderate, with only 2 days in the unhealthy for sensitive groups' category according to Table 4 in section 3.1. Pollutants of concern in the area are ozone and $PM_{2.5}$ since these are the pollutants that determined the AQI over the last three years.

Air Quality Index

Figure 36 AQI Summary Information for Garfield County



County CAP Emissions

Table 28Table 21 below lists the 2014 emissions inventory of CAP by source for counties within the Kanab field office and Grand Staircase Escalante National Monument boundaries.

Table 28, 2014 Criteria Air Pollutant Emissions (tpy) by Source for Kanab FO and GSENM-KEPA

County	Source	CO	NOx	PM10	PM2.5	SOx	VOCs
Garfield	Area Sources	719.72	279.13	2,088.77	323.19	1.42	280.78
	Area Sources Oil and Gas	13.12	8.53	0.17	0.17	0.03	130.26
	Non-Road Mobile	2,230.15	84.52	34.29	31.77	0.42	896.46
	On-Road Mobile	809.90	275.40	59.02	20.99	1.04	79.01
	Point Sources	3.86	1.74	1.26	0.40	0.92	0.36

County	Source	CO	NOx	PM10	PM2.5	SOx	VOCs
	Biogenics	8,853.31	0.00	0.00	0.00	0.00	42,892.08
	Wildfires	24.62	0.70	2.98	2.68	0.00	4.20
	County Total	**12,654.7**	**650.02**	**2,186.49**	**379.20**	**3.83**	**44,283.15**
Kane	Area Sources	178.05	320.72	1,363.97	167.90	1.70	98.51
	Area Sources Oil and Gas	0.00	0.00	0.00	0.00	0.00	0.00
	Non-Road Mobile	2,173.12	83.20	28.11	25.98	0.36	821.93
	On-Road Mobile	1,054.00	396.90	105.07	35.46	1.36	110.40
	Point Sources	27.16	53.69	47.31	5.27	8.88	10.90
	Biogenics	9,038.86	0.00	0.00	0.00	0.00	42,588.57
	Wildfires	0.00	0.00	0.00	0.00	0.00	0.00
	County Total	**12,471.2**	**854.51**	**1,544.46**	**234.61**	**12.30**	**43,630.31**

Downstream GHG Emissions

Estimated well production for Kanab and Grand Staircase Escalante was calculated for the GSENM-KEPA RMP. Oil production is based on 15 years of production data from the Upper Valley field, and accounted for the highest producing year and decline. Table 29 contains the average annual oil production and downstream GHG emissions per well based on information from the RMP. Estimated GHG emissions in metric tons (MT) CO_2e are based on the production and equivalency emission factors from the EPA.

Table 29, Well Production and Downstream GHG Emission Estimates for Wells in the Kanab FO and GSENM-KEPA Area

Field Office	Annual Oil Production per well (bbl)[(1)]	GHG Combustion Emissions per well (MT CO_2e)[(2)]
Kanab and GSENM-KEPA	13,961	6,003

1) *Production data based on information gathered for the GSENM-KEPA RMP.*
2) *Oil well GHG indirect emission factor: 0.43 MT CO_2e per barrel* (EPA, 2018)

Climate Normals

Kanab Field Office and GSENM-KEPA are mostly in the South Central climate division, with a small portion in the Southeast climate division. The southeast climate division on average is 5ºF warmer and has 6 inches less annual precipitation. Prevailing winds are primarily from a westerly direction. Table 15 lists average seasonal temperatures for cities within the Kanab field office boundaries, while Table 31 and Table 32 list the average maximum and minimum temperatures respectively. Average seasonal precipitation can be found in Table 33. Wind information is provided in Figure 37, Figure 38, Table 34, and Table 35.

Table 30, Average (1981-2010) Temperatures in the Kanab FO and GSENM-KEPA

Location	Average Temperature (F)				
	Winter	Spring	Summer	Autumn	Annual
KANAB	37.4	53.2	73.5	55.7	55.1
ESCALANTE	32	50.6	71.2	51.7	51.5
BRYCE CANYON	20.8	38.8	59.8	41.5	40.3

Table 31, Average (1981-2010) of Maximum Temperatures in the Kanab FO and GSENM-KEPA

Location	Maximum Temperature (F)				
	Winter	Spring	Summer	Autumn	Annual
KANAB	49.4	68.7	90.4	70.6	69.9
ESCALANTE	44.8	66.4	89.1	67.3	67
BRYCE CANYON	35.7	54.9	78.1	57.6	56.7

Table 32, Average (1981-2010) of Minimum Temperatures in the Kanab FO and GSENM-KEPA

Location	Minimum Temperature (F)				
	Winter	Spring	Summer	Autumn	Annual
KANAB	25.4	37.8	56.7	40.8	40.2
ESCALANTE	19.2	34.7	53.3	36.1	35.9
BRYCE CANYON	5.9	22.8	41.5	25.4	24

Table 33, Average (1981-2010) Precipitation for Kanab FO and GSENM-KEPA

Location	Precipitation (in)					Snow Fall (in)				
	Winter	Spring	Summer	Autumn	Annual	Winter	Spring	Summer	Autumn	Annual
KANAB	4.92	3.06	2.91	4.3	15.19	17.7	3.9	0	2.4	24
ESCALANTE	2.44	1.82	2.98	2.93	10.17	20.1	4	0	1.9	26
BRYCE CANYON	2.6	2.57	3.25	3.63	12.05	NA	NA	NA	NA	NA

Figure 37, Wind Rose for the Bryce Canyon Airport

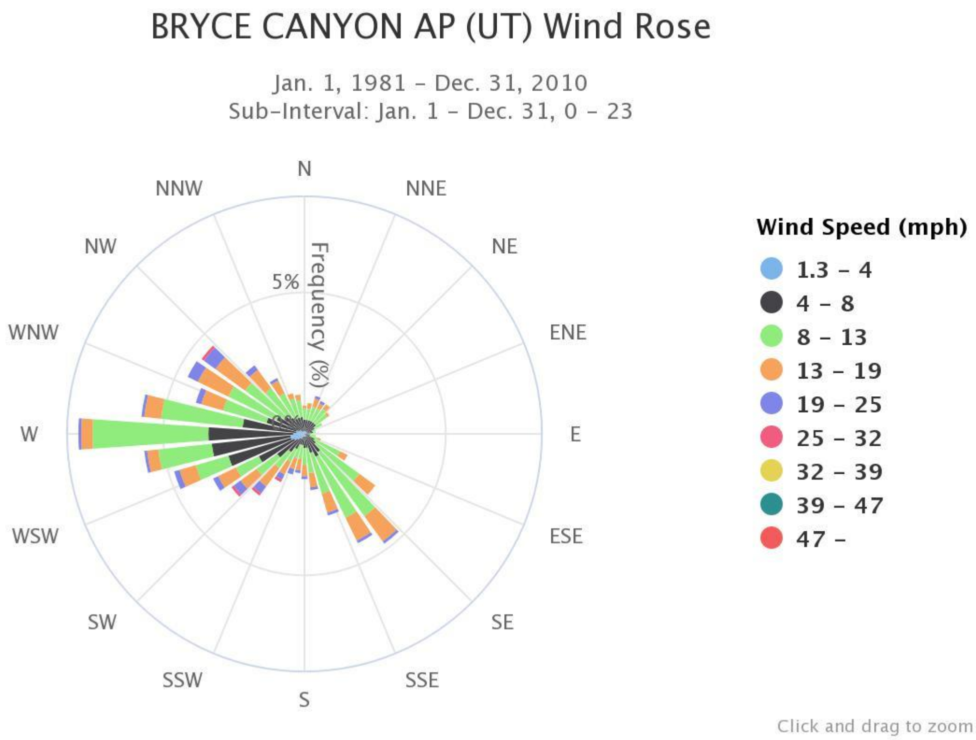


Figure 38, Wind Rose for the Page AZ Airport

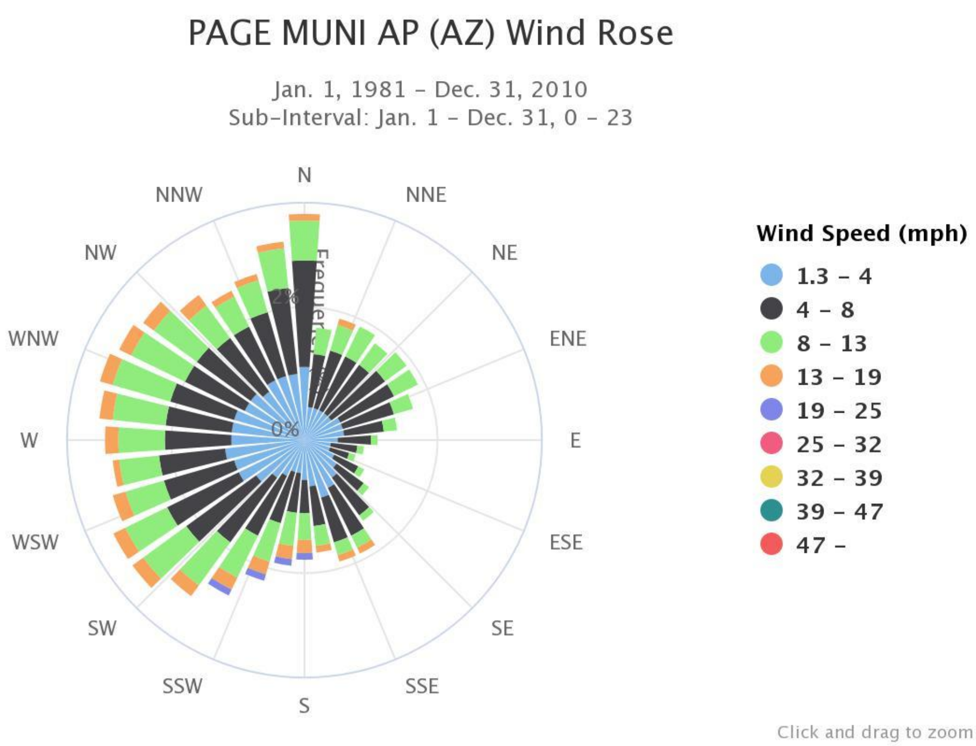


Table 34, Prevailing Wind Directions in the Kanab FO and GSENM-KEPA

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
BRYCE CANYON (KBCE)	W	W	W	W	W	W	W	W	W	W	W	W	W
PAGE (KPGA)	W	W	W	W	W	W	W	S	N	W	W	W	W

Table 35, Average Wind Speed (mph) in the Kanab FO and GSENM-KEPA

STATION	Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
BRYCE CANYON (KBCE)	2001-2011	7.8	8.4	9	10.2	9.5	9.3	7.7	7.6	8.2	8.1	7.8	7.4	8.4
PAGE (KPGA)	2001-2011	3	3.9	5.2	6.6	6.1	5.9	5.3	5	4.8	4.1	3.2	2.9	4.7

Climate Trends

Historical yearly precipitation totals (1895-2017) and trends from the current climate normal period (1981-2010) for the South Central and Southeast climate divisions are shown in section 4.2.2, Figure 17 and Figure 20. Annual average temperature (1895-2017) and trends from the current climate normal period (1981-2010) are shown in Figure 24 and Figure 27 of section 4.2.2.

Appendix D (Moab Field Office)

Overview

Air quality in the Moab Field Office area is generally good. The area is in attainment or unclassifiable for all NAAQS pollutants. AQI summary information for adjacent San Juan County presented in Table 4 show less than one percent of days having unhealthy air. Pollutants of concern are Ozone and $PM_{2.5}$ since these are the pollutants that determined the AQI over the last three years.

Air Quality Index

No air quality index data is available for Grand County.

County CAP Emissions

Table 36 below lists the 2014 emissions inventory of CAP by source for counties within the Moab field office boundaries.

Table 36, 2014 Criteria Air Pollutant Emissions (tpy) by Source for the Moab FO

County	Source	CO	NOx	PM10	PM2.5	SOx	VOCs
Grand	Area Sources	193.04	313.05	1,288.53	202.89	0.97	133.41
	Area Sources Oil and Gas	494.40	562.99	31.38	20.05	13.60	6,140.95
	Non-Road Mobile	3,260.68	248.06	51.10	47.40	2.29	1,293.25
	On-Road Mobile	2,909.00	1,798.00	238.16	94.35	4.08	308.50
	Point Sources	94.34	244.57	23.75	7.10	2.10	119.35
	Biogenics	7,462.91	0.00	0.00	0.00	0.00	34,422.37
	Wildfires	0.00	0.00	0.00	0.00	0.00	0.00
	County Total	**14,414.4**	**3,166.67**	**1,632.92**	**371.79**	**23.04**	**42,417.83**

Downstream GHG Emissions

Historical production data for the Moab Field Office was provided by Eric Jones, Petroleum Engineer for the Moab Field Office. Production estimates were based on his 31 years' experience in the Moab Field Office and are presented in Table 37 for each oil and gas producing area within the field office boundaries. To estimate well production outside these areas the Grand County average may be used. Each well is considered to produce both oil and gas, and average production for both is used to calculate total downstream GHG emissions. Estimated GHG emissions are in metric tons (MT) CO_2e and are based on the production and equivalency emission factors from the EPA.

Table 37, Well Production and Downstream GHG Emission Estimates for Wells in the Moab FO Area

	Oil Production per Well				Gas Production per Well			
Area	**Average (bbl/day)**	**High (bbl/day)**	**Annual Average (bbl)**	**Annual High (bbl)**	**Average (mcf/day)**	**High (mcf/day)**	**Annual Average (mcf)**	**Annual High(mcf)**
Cisco & Book Cliffs	1	5	365	1,825	20	100	7,300	36,500
Greater Lisbon	5	30	1,825	10,950	25	100	9,125	36,500
Paradox Belt	10	75	3,650	27,375	8	65	2,920	23,725
Grand County	2.83	-	1023	-	23.94	-	8,738	-

Production estimates provided by Moab Field Office Petroleum Engineer, Eric Jones

County production is based on 516 active wells and year-end production data from 2008-2017, UDOGM reports.

Table 38, Estimated Downstream GHG Emissions for Wells in the Moab FO Area

Area	Average GHG Emission (MT CO_2e/yr.)	High GHG Emissions (MT CO_2e/yr.)
Cisco & Book Cliffs	559	2,796
Greater Lisbon	1,288	6,720
Paradox Belt	1,730	13,078
Grand County	920	NA

Oil well GHG indirect emission factor: 0.43 MT CO_2e per barrel (EPA, 2018)

Gas well GHG indirect emission factor are averaged from: 0.0551 MT CO_2e per million cubic feet (EPA, 2018)

Climate Normals

The Moab Field Office is located in the Southeast Utah climate division. This climate division is generally hot and dry, with average precipitation less than 10 inches per year. Higher elevation locations near the La Sal Mountains are cooler and receive more precipitation. Prevailing wind directions are primarily from a westerly direction Table 39 lists average seasonal temperatures for cities within the Moab field office boundaries, while Table 40 and Table 41 list the average maximum and minimum temperatures respectively. Average seasonal precipitation can be found in Table 42. Wind information is provided in Figure 39, Table 43, and Table 44.

Table 39, Average (1981-2010) Temperatures in the Moab FO

	Average Temperature (F)				
Location	**Winter**	**Spring**	**Summer**	**Autumn**	**Annual**
MOAB	34.2	57.4	79	56.6	56.9
GREEN RIVER	31	55.4	77.2	53.9	54.5

Table 40, Average (1981-2010) of Maximum Temperatures in the Moab FO

Location	Maximum Temperature (F)				
	Winter	Spring	Summer	Autumn	Annual
MOAB	46.1	72.8	96.1	72.1	71.9
GREEN RIVER	44.9	72.4	95.5	71	71.1

Table 41, Average (1981-2010) of Minimum Temperatures in the Moab FO

Location	Minimum Temperature (F)				
	Winter	Spring	Summer	Autumn	Annual
MOAB	22.3	42.1	61.8	41.2	41.9
GREEN RIVER	17	38.4	58.8	36.9	37.9

Table 42, Average (1981-2010) Precipitation for the Moab FO

Location	Precipitation (in)					Snow Fall (in)				
	Winter	Spring	Summer	Autumn	Annual	Winter	Spring	Summer	Autumn	Annual
MOAB	1.95	2.36	2.35	2.79	9.45	5.3	0.3	0	0.7	6.3
GREEN RIVER	1.51	1.86	1.96	2.27	7.6	6.5	0.8	0	0.3	7.6

Figure 39, Wind Rose for the Moab Canyonlands Airport

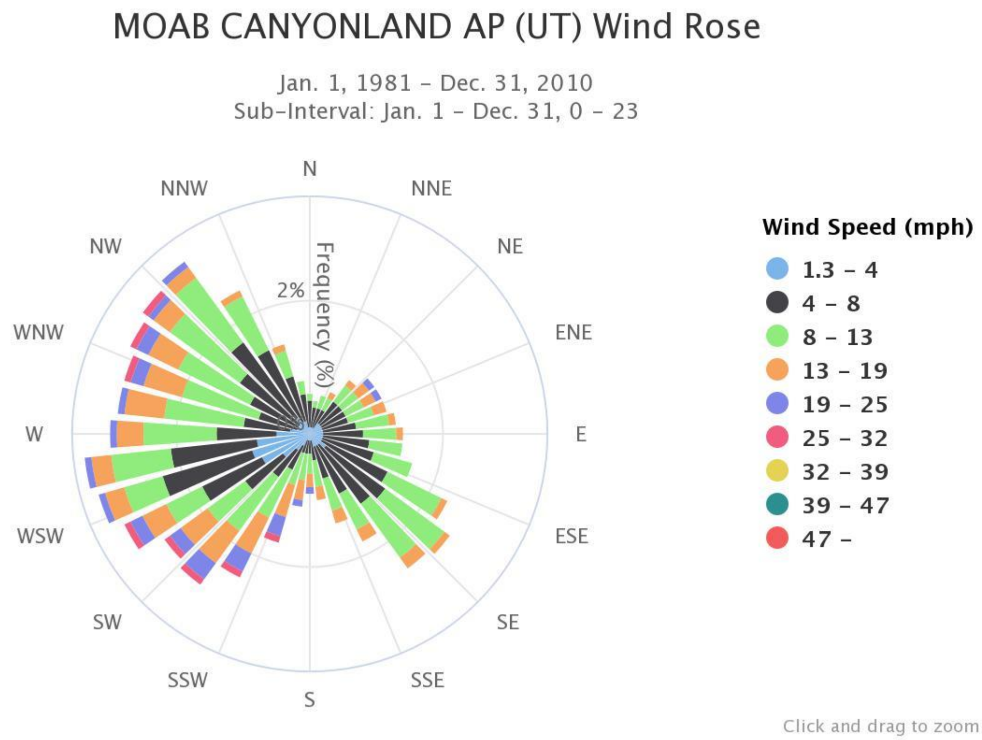


Table 43, Prevailing Wind Directions in the Moab FO

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
MOAB (KCNY)	NW	W	W	W	W	SW	SE	E	W	W	W	NW	W

Table 44, Average Wind Speed (mph) in the Moab FO

STATION	Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
MOAB (KCNY)	2001-2011	3.8	4.9	6.6	8.8	8.1	7.9	6.8	6.5	6	5.2	4.3	3.8	6.1

Climate Trends

Historical yearly precipitation totals (1895-2017) and trends from the current climate normal period (1981-2010) for the Southeast climate divisions are shown in section 4.2.2, Figure 20. Annual average temperature (1895-2017) and trends from the current climate normal period (1981-2010) are shown in Figure 27 of section 4.2.2.

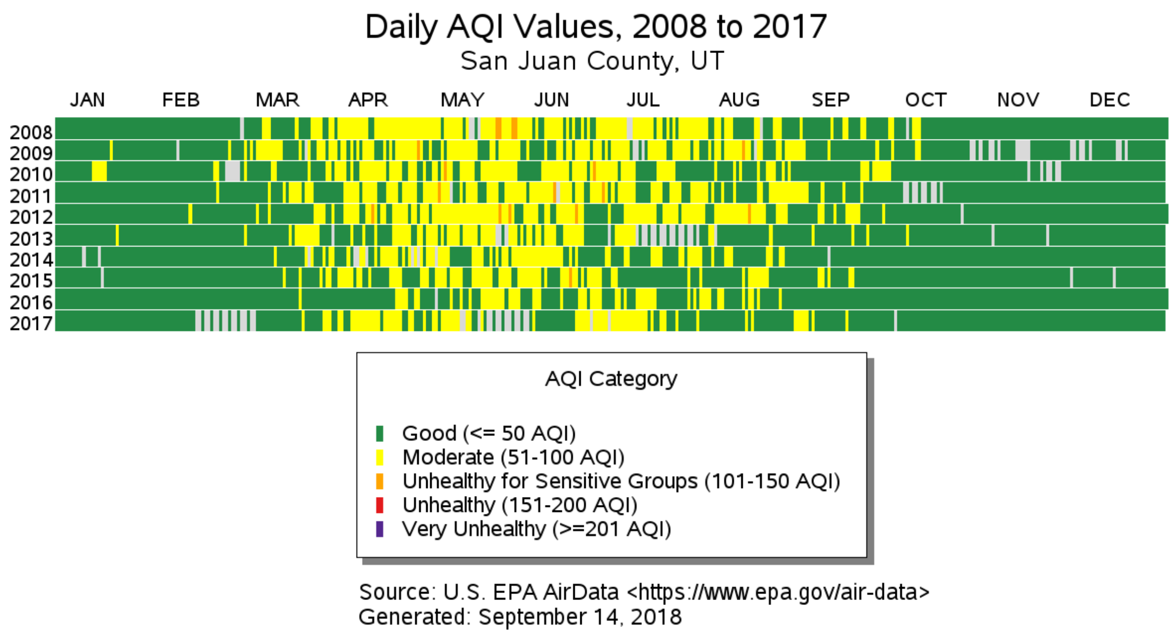
Appendix E (Monticello Field Office and BENM)

Overview

Air quality in the Monticello Field Office and Bears Ears National Monument (BENM) area is generally good. The area is in attainment or unclassifiable for all NAAQS pollutants. AQI Summary information in Figure 40 below and in section 3.1 Table 4 show less than one percent of days having unhealthy air. Pollutants of concern are Ozone and $PM_{2.5}$ since these are the pollutants that determined the AQI over the last three years.

Air Quality Index

Figure 40 AQI Summary Information for San Juan County



County CAP Emissions

Table 45 below lists the 2014 emissions inventory of CAP by source for counties within the Monticello field office and BENM boundaries.

Table 45, 2014 Criteria Air Pollutant Emissions (tpy) by Source for the Monticello FO and BENM

County	Source	CO	NOx	PM10	PM2.5	SOx	VOCs
San Juan	Area Sources	384.42	649.79	4,252.57	524.24	2.72	218.46
	Area Sources Oil and Gas	296.09	199.29	2.39	2.38	0.93	11,840.05
	Non-Road Mobile	1,718.66	103.03	21.12	19.67	0.42	535.85
	On-Road Mobile	1,551.00	747.70	239.52	78.86	2.89	153.20
	Point Sources	240.37	357.52	234.93	88.63	505.93	60.30
	Biogenics	15,795.81	0.00	0.00	0.00	0.00	72,896.61

County	Source	CO	NOx	PM10	PM2.5	SOx	VOCs
	Wildfires	1.35	0.04	0.16	0.15	0.00	0.23
	County Total	**19,987.7**	**2,057.37**	**4,750.69**	**713.93**	**512.89**	**85,704.70**

Downstream GHG Emissions

Estimated production data for San Juan County is shown in Table 46. Total number of wells in the county are listed. Each well is considered to produce both oil and gas, and average production for both is used to calculate total downstream GHG emissions. Estimated GHG emissions are in metric tons (MT) CO_2e and are based on the production and equivalency emission factors from the EPA.

Table 46, Well Production and Downstream GHG Emission Estimates for Wells in the Monticello FO Area

County	Total Oil (bbl)	Total Gas (mcf)	Producing Wells in County	Average Oil Production	Average Gas Production	MT CO_2e per well
San Juan	4,193,153	10,291,037	754	5,563	13,652	3,143

Data source - *https://oilgas.ogm.utah.gov/oilgasweb/publications/monthly-rpts-by-cnty.xhtml*

Annual oil and gas production averaged over the last ten years (2008-2017)

Producing wells is determined by averaging the number of producing wells over the last ten year (2008-2017).

Oil well GHG indirect emission factor: 0.43 MT CO_2e per barrel (EPA, 2018)

Gas well GHG indirect emission factor are averaged from: 0.0551 MT CO_2e per million cubic feet (EPA, 2018)

There is some uncertainty in estimates of oil and gas production and ultimately downstream GHG emission estimates. Production can vary by well and from one year to the next. To better understand the range of potential downstream GHG emissions the standard deviation of annual productions is calculated from 2008 to 2017. Statistically, one standard deviation will include about 68% of the wells used to calculate the mean and two standard deviations will cover 95%. In San Juan County the annual standard deviation of oil and gas production per well is 404 bbl/yr and 1,747 mcf/yr respectively. This results in range of ±270 MT CO_2e/yr per well from the average downstream GHG emissions in San Juan County.

Climate Normals

The Monticello Field Office and BENM are located in the Southeast Utah climate division. This climate division is generally hot and dry, with average precipitation less than 10 inches per year. Higher elevation locations are cooler and receive more precipitation than the climate division average. Table 47 lists average seasonal temperatures for cities within the Monticello Field Office and BENM boundaries, while Table 48 and Table 49 list the average maximum and minimum temperatures respectively. Average seasonal precipitation can be found in Table 50.

Table 47, Average (1981-2010) Temperatures for the Monticello FO and BENM

Location	Average Temperature (F)				
	Winter	Spring	Summer	Autumn	Annual
BLANDING	33.7	51.9	73.6	53.8	53.3
BLUFF	34.4	56	77	54.8	55.7
MONTICELLO	26.5	45.2	66.2	47	46.3
NATURAL BRIDGES	31	48.8	71.2	51.2	50.7

Table 48, Average (1981-2010) of Maximum Temperatures for the Monticello FO and BENM

Location	Maximum Temperature (F)				
	Winter	Spring	Summer	Autumn	Annual
BLANDING	44	65.5	88.7	66.4	66.3
BLUFF	46.9	72.2	94	70.5	71
MONTICELLO	37.1	58.8	81.8	60.3	59.6
NATURAL BRIDGES	41.2	61.5	85.5	63.2	63

Table 49, Average (1981-2010) of Minimum Temperatures for the Monticello FO and BENM

Location	Minimum Temperature (F)				
	Winter	Spring	Summer	Autumn	Annual
BLANDING	23.4	38.4	58.5	41.1	40.4
BLUFF	21.8	39.9	60	39.2	40.3
MONTICELLO	15.9	31.5	50.5	33.6	33
NATURAL BRIDGES	20.8	36.1	57	39.2	38.3

Table 50, Average (1981-2010) Precipitation for the Monticello FO and BENM

Location	Precipitation (in)					Snow Fall (in)				
	Winter	Spring	Summer	Autumn	Annual	Winter	Spring	Summer	Autumn	Annual
BLANDING	3.98	2.78	3.08	4.02	13.86	25.4	6.6	0	4	36
BLUFF	2.05	1.55	1.73	2.44	7.77	7.8	0.2	0	0.4	8.4
MONTICELLO	4.49	2.98	3.92	4.84	16.23	40.4	14.4	0	9.3	64.1
NATURAL BRIDGES	2.8	2.76	3.42	3.93	12.91	22.6	7.8	0	4	34.4

Climate Trends

Historical yearly precipitation totals (1895-2017) and trends from the current climate normal period (1981-2010) for the Southeast climate divisions are shown in section 4.2.2, Figure 20. Annual average temperature (1895-2017) and trends from the current climate normal period (1981-2010) are shown in Figure 27 of section 4.2.2.

Appendix F (Price Field Office)

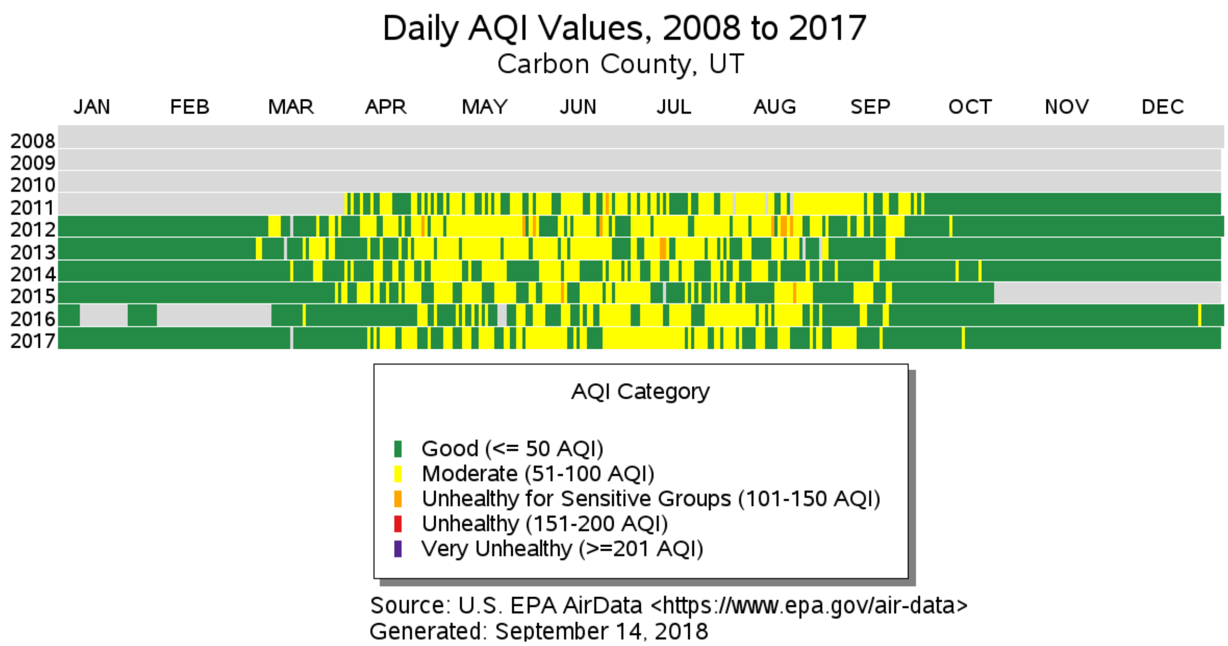
Overview

Air quality in the Price Field Office area is generally good. The area is in attainment or unclassifiable for all NAAQS pollutants. However, portions of the field office in Carbon County are adjacent to the Uinta Basin NAA and may have higher pollutant concentrations at times. AQI Summary information is available for Emery County. Figure 41 below and Table 4 in section 3.1 show less than one percent of days having unhealthy air in Carbon County. Pollutants of concern are Ozone and NO_2 since these are the pollutants that determined the AQI over the last three years.

Air Quality Index

No air quality index data is available for Emery County.

Figure 41 AQI Summary Information for Carbon County



County CAP Emissions

Table 51 below lists the 2014 emissions inventory of CAP by source for counties within the Price field office boundaries.

Table 51, 2014 Criteria Air Pollutant Emissions (tpy) by Source for the Price FO

County	Source	CO	NOx	PM10	PM2.5	SOx	VOCs
Carbon	Area Sources	421.54	165.31	4,005.14	548.07	1.07	292.54
	Area Sources Oil and Gas	836.11	869.80	44.39	36.76	10.96	3,126.61
	Non-Road Mobile	981.32	372.99	23.41	22.49	3.97	173.64

County	Source	CO	NOx	PM10	PM2.5	SOx	VOCs
	On-Road Mobile	2,790.00	1,032.00	311.88	103.41	3.74	296.08
	Point Sources	360.02	3,887.50	525.78	138.72	10,314.2	222.28
	Biogenics	2,568.87	0.00	0.00	0.00	0.00	12,363.9
	Wildfires	161.86	4.61	19.58	17.63	0.00	27.65
	County Total	**8,119.72**	**6,332.21**	**4,930.18**	**867.08**	**10,333.9**	**16,502.7**
Emery	Area Sources	157.72	254.67	3,332.02	374.29	0.73	148.09
	Area Sources Oil and Gas	160.51	158.07	8.93	8.38	1.18	482.51
	Non-Road Mobile	475.77	227.41	16.30	15.70	1.34	103.74
	On-Road Mobile	2,270.00	1,390.00	272.81	98.83	3.76	238.71
	Point Sources	7,145.99	18,372.6	1,516.36	752.66	6,420.08	208.28
	Biogenics	7,627.02	0.00	0.00	0.00	0.00	34,859.9
	Wildfires	0.00	0.00	0.00	0.00	0.00	0.00
	County Total	**17,837.0**	**20,402.8**	**5,146.42**	**1,249.86**	**6,427.09**	**36,041.2**

Downstream GHG Emissions

Estimated production data for Carbon and Emery Counties are shown in Table 52. Total number of wells in the county are listed. Each well is considered to produce both oil and gas, and the average production for both is used to calculate total downstream GHG emissions. Estimated GHG emissions are in metric tons (MT) CO_2e and are based on the production and equivalency emission factors from the EPA.

Table 52, Well Production and Downstream GHG Emission Estimates for Wells in the Price FO Area

County	Total Oil (bbl)	Total Gas (mcf)	Producing Wells in County	Average Oil Production	Average Gas Production	MT CO_2e per well
Carbon	64,516	76,083,722	1046	62	72,710	4,026
Emery	3,375	11,495,374	306	11	37,603	2,073

Data source - https://oilgas.ogm.utah.gov/oilgasweb/publications/monthly-rpts-by-cnty.xhtml

Annual oil and gas production averaged over the last ten years (2008-2017)

Producing wells is determined by averaging the number of producing wells over the last ten year (2008-2017).

Oil well GHG indirect emission factor: 0.43 MT CO_2e per barrel (EPA, 2018)

Gas well GHG indirect emission factor are averaged from: 0.0551 MT CO_2e per million cubic feet (EPA, 2018)

There is some uncertainty in estimates of oil and gas production and ultimately downstream GHG emission estimates. Production can vary by well and from one year to the next. To better understand the range of potential downstream GHG emissions the standard deviation of annual productions is calculated from 2008 to 2017. Statistically, one standard deviation will include about 68% of the wells used to calculate the mean and two standard deviations will cover 95%. In Carbon County the annual standard deviation of oil and gas production per well is 16 bbl/yr and 16,846 mcf/yr respectively. In Emery County the standard deviation in annual production is 12 bbl/yr for oil and 11,128 mcf/yr for gas. This results in a range of ±935 MT CO_2e/yr per well from the average downstream GHG emissions in Carbon County, ±618 MT CO_2e/yr per well from the average downstream GHG emissions in Emery County.

Climate Normals

The Price Field Office is split between Northern Mountains, Uinta Basin, and Southeast climate divisions of Utah. Areas in the Northern Mountains climate division have the coolest average temperatures and most precipitation. Most of Emery County is in the Southeast climate divisions which on average is the warmest and driest part of the field office. Prevailing winds are primarily from a northerly or northwesterly direction. Table 53 lists average seasonal temperatures for cities within the Price field office boundaries, while Table 54 and Table 55 list the average maximum and minimum temperatures respectively. Average seasonal precipitation can be found in Table 56. Wind information is provided in Figure 42, Table 57, and Table 58.

Table 53, Average (1981-2010) Temperatures in the Price FO

Location	Average Temperature (F)				
	Winter	Spring	Summer	Autumn	Annual
PRICE	26.6	48.2	70.6	49	48.7

Table 54, Average (1981-2010) of Maximum Temperatures in the Price FO

Location	Maximum Temperature (F)				
	Winter	Spring	Summer	Autumn	Annual
PRICE	36.9	61.6	86	61.7	61.7

Table 55, Average (1981-2010) of Minimum Temperatures in the Price FO

Location	Minimum Temperature (F)				
	Winter	Spring	Summer	Autumn	Annual
PRICE	16.3	34.7	55.2	36.2	35.7

Table 56, Average (1981-2010) Precipitation for the Price FO

Location	Precipitation (in)					Snow Fall (in)				
	Winter	Spring	Summer	Autumn	Annual	Winter	Spring	Summer	Autumn	Annual
PRICE	2.02	2.38	2.64	3.01	10.05	NA	NA	NA	NA	NA

Figure 42, Wind Rose for the Price Airport

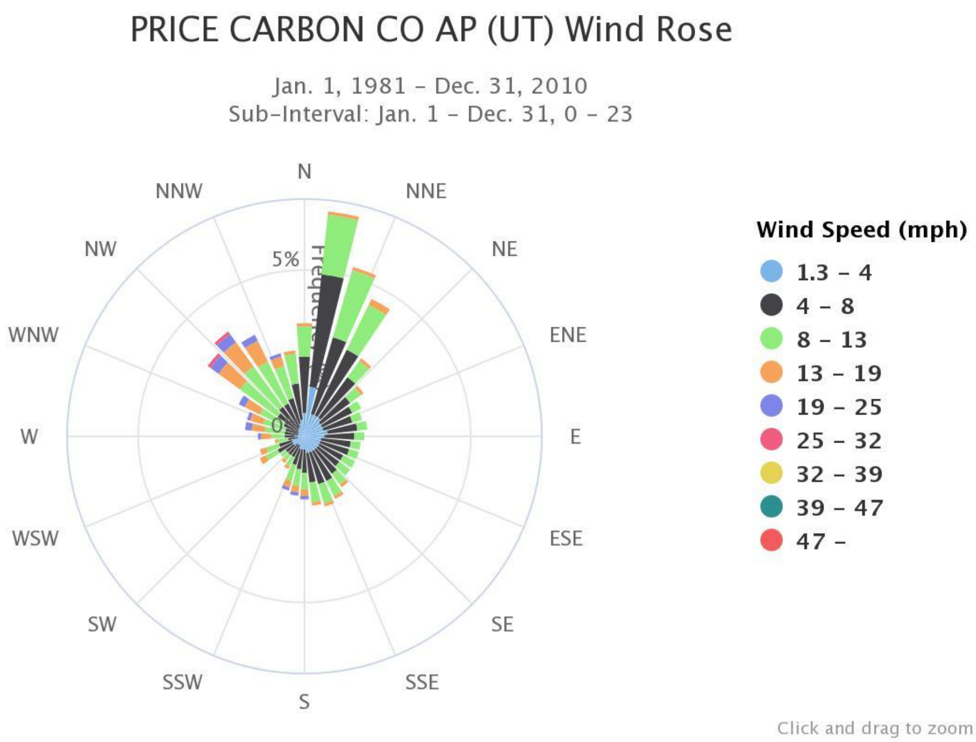


Table 57, Prevailing Wind Directions in the Price FO

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
PRICE (KPUC)	N	N	N	N	N	N	N	N	N	N	N	N	N

Table 58, Average Wind Speed (mph) in the Price FO

STATION	Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
PRICE (KPUC)	2001-2011	4.6	5.6	7.8	8.7	8.1	7.8	7.2	6.8	6.8	6.4	5.9	4.7	6.7

Climate Trends

Historical yearly precipitation totals (1895-2017) and trends from the current climate normal period (1981-2010) for the Northern Mountains, Uinta Basin and Southeast climate divisions are shown in section 4.2.2 Figure 18 through Figure 20. Annual average temperature (1895-2017) and trends from the current climate normal period (1981-2010) are shown in Figure 25 through Figure 27 of section 4.2.2.

Appendix G (Richfield Field Office)

Overview

Air quality in the Richfield Field Office is generally good. The area is in attainment or unclassifiable for all NAAQS pollutants. However, portions of the field office in Sanpete County are adjacent to the Utah County PM_{10} NAA and may see higher pollutant concentrations at times. AQI summary information in Figure 43, Figure 44 below and in section 3.1 Table 4 show less than one percent of days having unhealthy air in Garfield and Wayne counties. Pollutants of concern in the area are ozone and $PM_{2.5}$ since these are the pollutants that determined the AQI over the last three years.

Air Quality Index

No air quality index data is available for Piute, Sanpete, and Sevier Counties.

Figure 43, AQI Summary Information for Garfield County

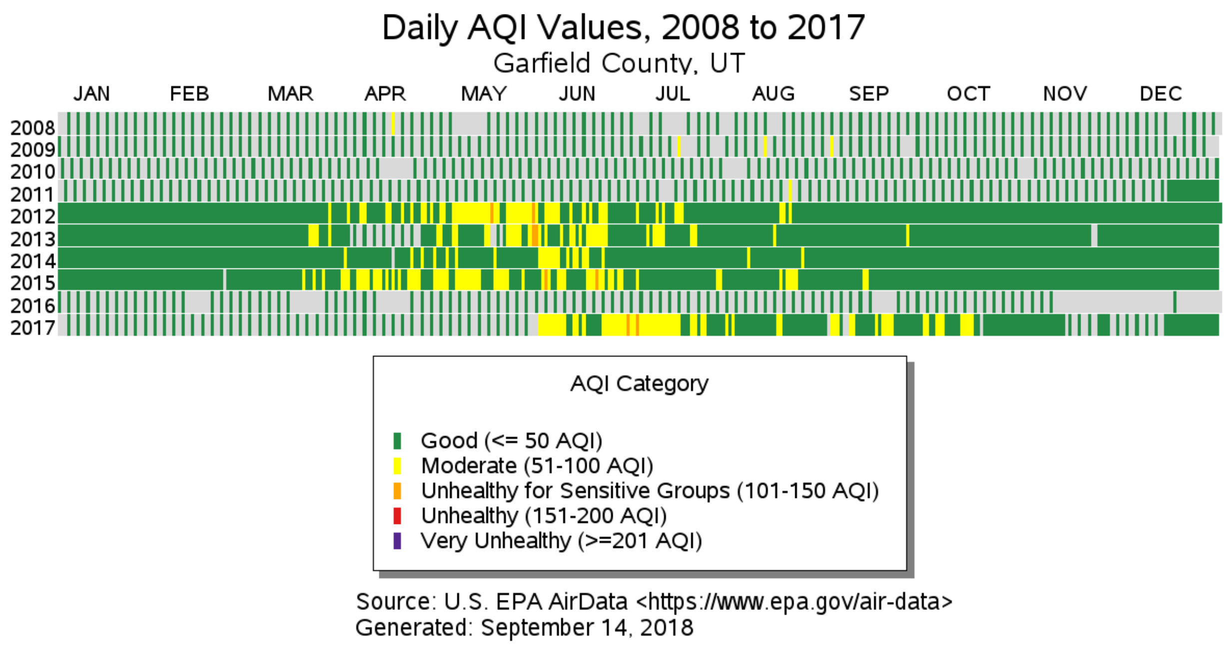
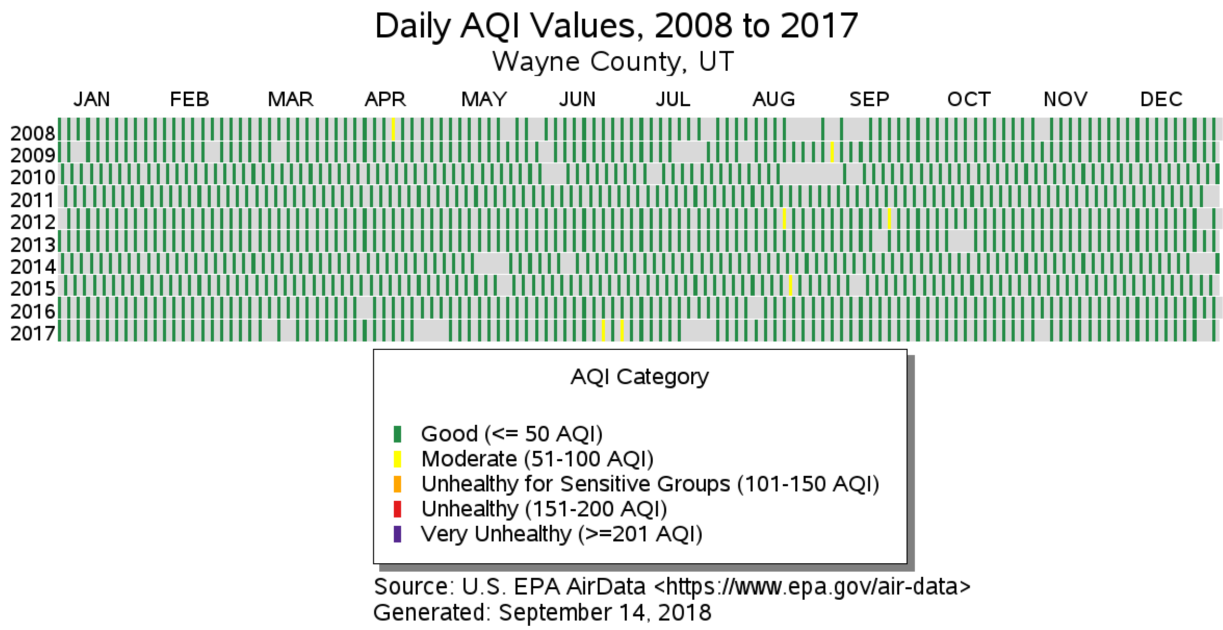


Figure 44, AQI Summary Information for Wayne County



County CAP Emissions

Table 59 below lists the 2014 emissions inventory of CAP by source for counties within the Richfield field office boundaries.

Table 59, 2014 Criteria Air Pollutant Emissions (tpy) by Source for the Richfield FO

County	Source	CO	NOx	PM10	PM2.5	SOx	VOCs
Garfield	Area Sources	719.72	279.13	2,088.77	323.19	1.42	280.78
	Area Sources Oil and Gas	13.12	8.53	0.17	0.17	0.03	130.26
	Non-Road Mobile	2,230.15	84.52	34.29	31.77	0.42	896.46
	On-Road Mobile	809.90	275.40	59.02	20.99	1.04	79.01
	Point Sources	3.86	1.74	1.26	0.40	0.92	0.36
	Biogenics	8,853.31	0.00	0.00	0.00	0.00	42,892.08
	Wildfires	24.62	0.70	2.98	2.68	0.00	4.20
	County Total	**12,654.7**	**650.02**	**2,186.49**	**379.20**	**3.83**	**44,283.15**
Piute	Area Sources	412.10	89.02	793.87	146.44	0.51	86.50
	Area Sources Oil and Gas	0.00	0.00	0.00	0.00	0.00	0.00
	Non-Road Mobile	112.51	17.69	1.91	1.82	0.04	31.32
	On-Road Mobile	251.40	104.70	27.94	9.68	0.33	28.07
	Point Sources	0.00	0.00	0.00	0.00	0.00	0.00
	Biogenics	1,368.85	0.00	0.00	0.00	0.00	7,046.13
	Wildfires	0.00	0.00	0.00	0.00	0.00	0.00
	County Total	**2,144.86**	**211.41**	**823.72**	**157.94**	**0.88**	**7,192.02**

County	Source	CO	NOx	PM10	PM2.5	SOx	VOCs
Sanpete	Area Sources	459.55	318.27	5,207.09	730.27	3.88	306.88
	Area Sources Oil and Gas	0.00	0.00	0.00	0.00	0.00	0.00
	Non-Road Mobile	999.75	107.95	16.40	15.46	0.28	293.87
	On-Road Mobile	2,711.00	689.70	174.28	60.43	2.43	313.60
	Point Sources	27.76	59.27	31.86	6.78	7.24	4.64
	Biogenics	2,648.44	0.00	0.00	0.00	0.00	13,916.44
	Wildfires	0.00	0.00	0.00	0.00	0.00	0.00
	County Total	**6,846.50**	**1,175.19**	**5,429.63**	**812.94**	**13.83**	**14,835.43**
Sevier	Area Sources	1,127.51	244.78	7,206.41	951.52	4.49	452.57
	Area Sources Oil and Gas	21.04	11.74	0.22	0.22	15.61	494.76
	Non-Road Mobile	1,844.52	202.28	34.98	33.08	0.52	498.24
	On-Road Mobile	2,946.00	1,425.00	209.40	79.14	3.70	332.40
	Point Sources	43.55	126.24	52.89	21.03	11.35	14.93
	Biogenics	3,011.69	0.00	0.00	0.00	0.00	15,039.60
	Wildfires	63.39	1.80	7.67	6.90	0.00	10.83
	County Total	**9,057.70**	**2,011.84**	**7,511.57**	**1,091.89**	**35.67**	**16,843.33**
Wayne	Area Sources	48.60	164.40	1,138.30	143.87	1.23	46.50
	Area Sources Oil and Gas	0.00	0.00	0.00	0.00	0.00	0.00
	Non-Road Mobile	785.76	35.24	12.05	11.20	0.14	288.39
	On-Road Mobile	449.20	124.80	30.98	10.39	0.49	45.38
	Point Sources	0.00	0.00	0.00	0.00	0.00	0.00
	Biogenics	4,692.59	0.00	0.00	0.00	0.00	21,802.10
	Wildfires	0.00	0.00	0.00	0.00	0.00	0.00
	County Total	**5,976.15**	**324.44**	**1,181.33**	**165.46**	**1.86**	**22,182.37**

Downstream GHG Emissions

No recent well production information is available for Piute and Wayne Counties and too little information is available for Sanpete and Sevier Counties to calculate average production. Statewide average oil well production and average gas well production (Table 13) should be used to estimate downstream GHG emissions for oil or gas well decisions in Piute, Wayne, Sanpete, and Sevier Counties.

Estimated well production for Garfield County was calculated for the GSENM-KEPA RMP. Oil production is based on 15 years of production data from the Upper Valley field, and accounted for the highest producing year and decline. Table 60 contains the average annual oil production and downstream GHG emissions per well based on information from the RMP. Estimated GHG emissions are in metric tons (MT) CO_2e and are based on the production and equivalency emission factors from the EPA.

Table 60, Well Production and Downstream GHG Emission Estimates for Wells in the Richfield FO Area

Field Office	Annual Oil Production per well (bbl)[(1)]	GHG Combustion Emissions per well ($MT\ CO_2e$)[(2)]
Kanab and GSENM-KEPA	13,961	6,003

1) *Production data based on information gathered for the GSENM-KEPA RMP.*
2) *Oil well GHG indirect emission factor: 0.43 MT CO_2e per barrel* (EPA, 2018)

Climate Normals

The Richfield Field Office is primarily located in the South Central climate division, with parts of Wayne and Garfield Counties also being in the Southeast climate division. Meteorological data in Table 61 to Table 64 show the differences between the two divisions, with Richfield being in the South Central division and Hanksville in the Southeast division. In general, the south Central division is cooler and wetter than the southeast division. Table 61 lists average seasonal temperatures for cities within the Richfield field office boundaries, while Table 62 and Table 63 list the average maximum and minimum temperatures respectively. Average seasonal precipitation can be found in Table 64.

Table 61, Average (1981-2010) Temperatures in the Richfield FO

	Average Temperature (F)				
Location	**Winter**	**Spring**	**Summer**	**Autumn**	**Annual**
RICHFIELD	30	48.6	68.7	49.5	49.3
HANKSVILLE	32	56	78.3	54.2	55.2

Table 62, Average (1981-2010) of Maximum Temperatures in the Richfield FO

	Maximum Temperature (F)				
Location	**Winter**	**Spring**	**Summer**	**Autumn**	**Annual**
RICHFIELD	42.3	64.6	86.9	66.4	65.2
HANKSVILLE	45.8	72.6	96.9	71.3	71.8

Table 63, Average (1981-2010) of Minimum Temperatures in the Richfield FO

	Minimum Temperature (F)				
Location	**Winter**	**Spring**	**Summer**	**Autumn**	**Annual**
RICHFIELD	17.7	32.7	50.4	32.7	33.4

HANKSVILLE	18.2	39.3	59.7	37.2	38.7

Table 64, Average (1981-2010) Precipitation for the Richfield FO

Location	Precipitation (in)					Snow Fall (in)				
	Winter	Spring	Summer	Autumn	Annual	Winter	Spring	Summer	Autumn	Annual
RICHFIELD	1.5	2.38	2.09	2.51	8.48	12.7	2.2	0	3.1	18
HANKSVILLE	1.11	1.37	1.4	2.05	5.93	4.4	0.6	0	0.8	5.8

Climate Trends

Historical yearly precipitation totals (1895-2017) and trends from the current climate normal period (1981-2010) for the South Central climate division is shown in section 4.2.2, Figure 17. Annual average temperature (1895-2017) and trends from the current climate normal period (1981-2010) is shown in Figure 24 of section 4.2.2.

Appendix H (Salt Lake Field Office)

Overview

Air quality in the Salt Lake Field Office is a concern. Nonattainment and maintenance areas for NO_2, CO, SO_2, ozone, PM_{10}, and $PM_{2.5}$ have been designated within the Salt Lake Field Office boundaries. AQI information for counties with BLM managed land is shown in Figure 45, Figure 46, and Figure 47 for Box Elder, Tooele, and Utah Counties respectively. These counties have 58-75% of days rated with good air and 2-4% of days rated with unhealthy air. Air quality is an issue in both the summer and winter seasons. Graphical AQI data is not presented for other counties in the field office boundaries as there is little or no BLM managed lands in the Counties or no available AQI information. Available AQI statistics for all available counties within the field office boundaries are presented in section 3.1 Table 4. Poor air quality in the area is heavily influenced by the urban and industrial areas along the Wasatch Front. State air monitoring stations are located throughout the area. Stations near Evanston WY may also be useful for BLM decisions in Rich County. Pollutants of concern for the field office are NO_2, SO_2, Ozone, $PM_{2.5}$, PM_{10}, and VOCs since these are the pollutants that determined the AQI over the last three years.

Air Quality Index

Figure 45 AQI Summary Information for Box Elder County

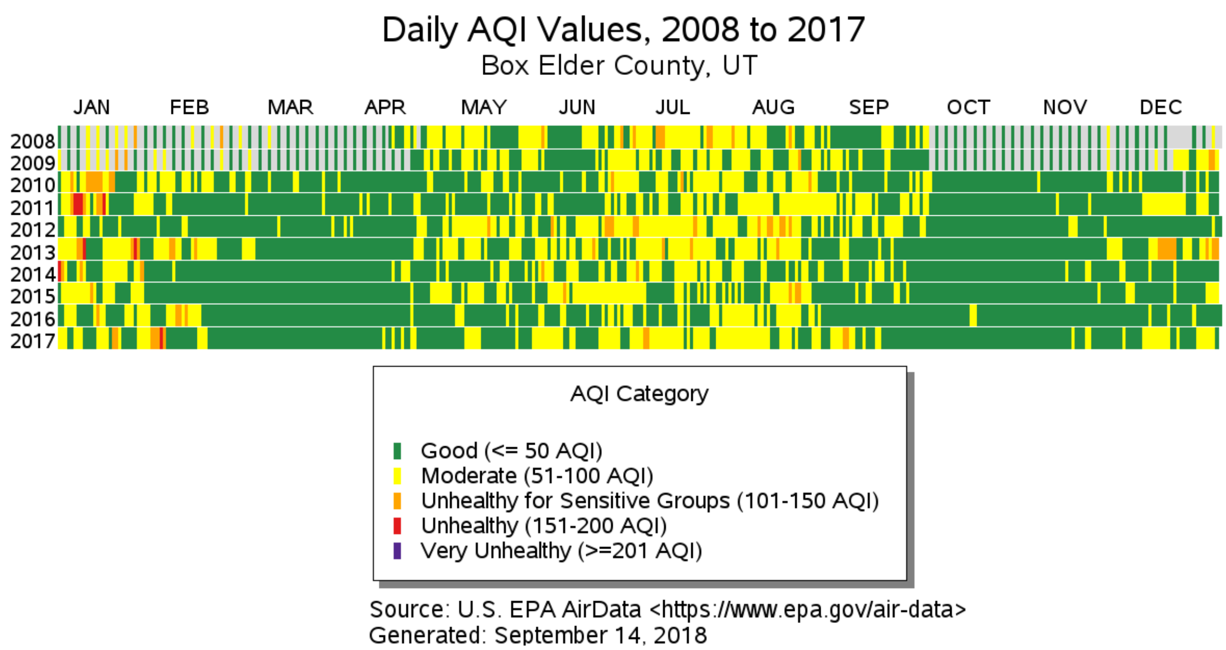


Figure 46 AQI Summary Information for Tooele County

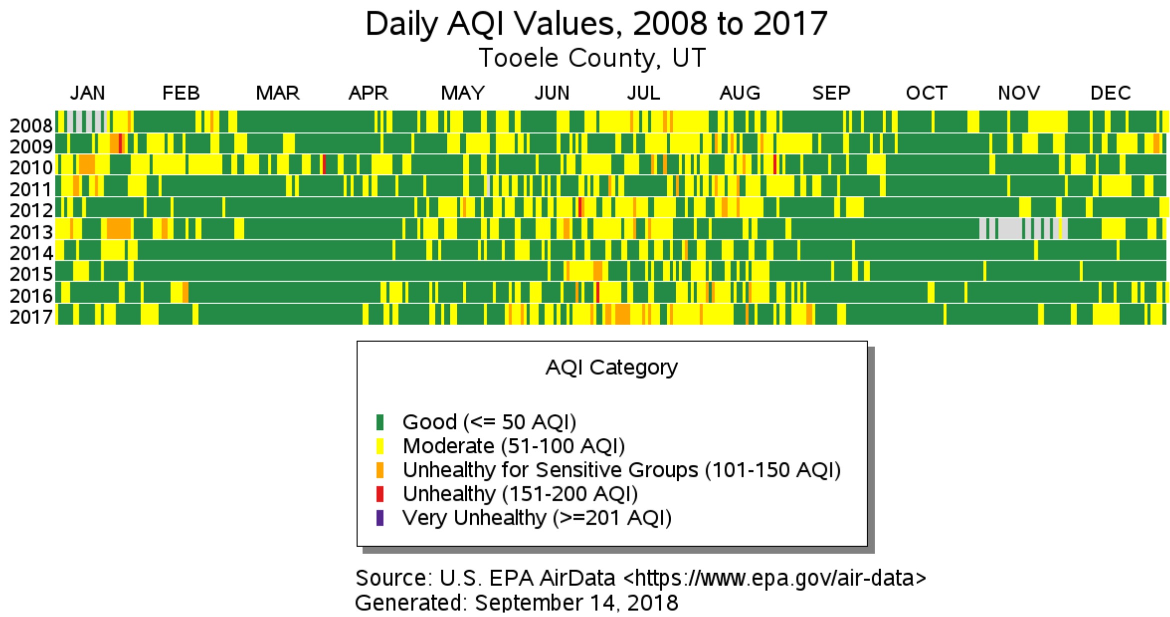
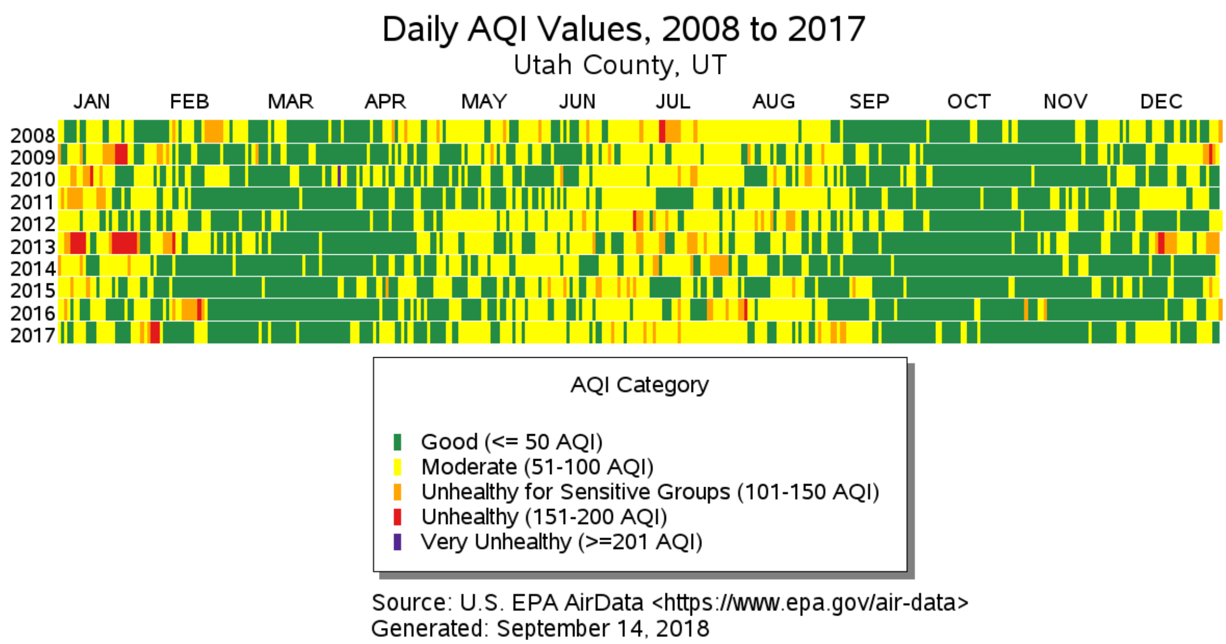


Figure 47 AQI Summary Information for Utah County



County CAP Emissions

Table 65 below lists the 2014 emissions inventory of CAP by source for counties within the Salt Lake field office boundaries with large amounts of BLM managed lands.

Table 65, 2014 Criteria Air Pollutant Emissions (tpy) by Source for the Salt Lake FO

County	Source	CO	NOx	PM10	PM2.5	SOx	VOCs
Box Elder	Area Sources	1,691.48	855.01	10,858.96	1,657.08	10.71	1,005.23
	Area Sources Oil and Gas	0.00	0.00	0.00	0.00	0.00	0.00
	Non-Road Mobile	6,369.35	1,330.74	75.58	71.73	8.56	1,466.78
	On-Road Mobile	7,083.00	2,500.00	365.04	138.28	8.94	694.20
	Point Sources	860.72	297.16	200.43	119.65	141.04	150.47
	Biogenics	7,809.02	0.00	0.00	0.00	0.00	33,193.39
	Wildfires	0.00	0.00	0.00	0.00	0.00	0.00
	County Total	**23,813.6**	**4,982.91**	**11,500.0**	**1,986.74**	**169.25**	**36,510.07**
Rich	Area Sources	505.23	159.73	2,369.64	446.95	2.31	59.13
	Area Sources Oil and Gas	0.00	0.00	0.00	0.00	0.00	0.00
	Non-Road Mobile	1,776.00	96.90	23.66	22.00	0.31	607.30
	On-Road Mobile	379.60	87.90	24.56	7.88	0.45	35.37
	Point Sources	0.00	0.00	0.00	0.00	0.00	0.00
	Biogenics	1,228.71	0.00	0.00	0.00	0.00	7,040.45
	Wildfires	0.00	0.00	0.00	0.00	0.00	0.00
	County Total	**3,889.54**	**344.53**	**2,417.86**	**476.83**	**3.07**	**7,742.25**
Tooele	Area Sources	713.55	909.70	5,964.34	803.03	4.34	626.86
	Area Sources Oil and Gas	0.00	0.00	0.00	0.00	0.00	0.00
	Non-Road Mobile	3,350.23	994.95	45.17	43.32	9.75	576.64
	On-Road Mobile	7,207.00	2,717.00	607.18	205.73	9.57	790.20
	Point Sources	510.95	1,501.57	1,696.39	1,003.85	56.97	719.42
	Biogenics	9,740.34	0.00	0.00	0.00	0.00	41,580.26
	Wildfires	1,513.86	43.10	183.17	164.85	0.00	258.60
	County Total	**23,035.9**	**6,166.32**	**8,496.25**	**2,220.78**	**80.63**	**44,551.98**
Utah	Area Sources	5,717.64	1,502.42	13,231.6	2,091.07	22.01	5,722.02
	Area Sources Oil and Gas	0.00	0.00	0.00	0.00	0.00	0.00
	Non-Road Mobile	14,797.8	1,812.22	177.67	169.60	11.67	1,705.67
	On-Road Mobile	27,899.0	8,550.00	1,714.82	618.74	45.03	2,875.00
	Point Sources	407.90	821.67	245.96	155.84	149.30	257.27
	Biogenics	3,227.27	0.00	0.00	0.00	0.00	18,273.77
	Wildfires	39.34	1.12	4.76	4.28	0.00	6.72
	County Total	**52,088.9**	**12,687.4**	**15,374.8**	**3,039.53**	**228.01**	**28,840.45**

Downstream GHG Emissions

No recent well production information is available to calculate average well production for counties within the Salt Lake Field Office, except for Summit County. Statewide average oil well production and average gas well production (Table 13) should be used to estimate downstream GHG emissions for oil or gas well decisions in the Salt Lake Field Office.

Estimated production data for Summit County is shown in Table 66. Total number of wells in the county are listed. Each well is considered to produce both oil and gas, and the average production for both is used to calculate total downstream GHG emissions. Estimated GHG emissions are in metric tons (MT) CO_2e and are based on the production and equivalency emission factors from the EPA.

Table 66, Well Production and Downstream GHG Emission Estimates for Wells in the Salt Lake FO Area

County	Total Oil (bbl)	Total Gas (mcf)	Producing Wells in County	Average Oil Production	Average Gas Production	MT CO_2e per well
Summit	224,088	5,325,188	62	3,644	86,588	6,329

Data source - https://oilgas.ogm.utah.gov/oilgasweb/publications/monthly-rpts-by-cnty.xhtml

Annual oil and gas production averaged over the last ten years (2008-2017)

Producing wells is determined by averaging the number of producing wells over the last ten year (2008-2017).

Oil well GHG indirect emission factor: 0.43 MT CO_2e per barrel (EPA, 2018)

Gas well GHG indirect emission factor are averaged from: 0.0551 MT CO_2e per million cubic feet (EPA, 2018)

There is some uncertainty in estimates of oil and gas production and ultimately downstream GHG emission estimates. Production can vary by well and from one year to the next. To better understand the range of potential downstream GHG emissions the standard deviation of annual productions is calculated from 2008 to 2017. Statistically, one standard deviation will include about 68% of the wells used to calculate the mean and two standard deviations will cover 95%. In Summit County the annual standard deviation of oil and gas production per well is 735 bbl/yr and 42,637 mcf/yr respectively. This results in a range of ±2,665 MT CO_2e/yr per well from the average downstream GHG emissions in Summit County.

Climate Normals

The Salt Lake Field Office is split between the Western, North Central, and Northern Mountain climate divisions in Utah. However, very little BLM managed land is in North Central climate division. In general, areas in the Northern Mountains division are much cooler and have more precipitation than areas in the other divisions. Prevailing wind directions are channeled by terrain and are primarily from a northerly or southerly direction. Table 67 lists average seasonal temperatures for cities within the Salt Lake field office boundaries, while Table 68 and Table 69 list the average maximum and minimum temperatures respectively. Average seasonal precipitation can be found in Table 70. Wind information is provided in Figure 48, Figure 49, Figure 50, Figure 51, Table 71, and Table 72.

Table 67, Average (1981-2010) Temperatures in the Salt Lake FO

	Average Temperature (F)				
Location	**Winter**	**Spring**	**Summer**	**Autumn**	**Annual**
WENDOVER	28.4	51.4	75.5	51.3	51.7
RANDOLPH	16.4	38.4	60.3	40.1	38.9
SALT LAKE CITY	31.2	51.4	75.2	53	52.8

Table 68, Average (1981-2010) of Maximum Temperatures in the Salt Lake FO

	Maximum Temperature (F)				
Location	**Winter**	**Spring**	**Summer**	**Autumn**	**Annual**
WENDOVER	36.4	61.7	87.5	61.5	61.9
RANDOLPH	28.5	52.1	78	56	53.7
SALT LAKE CITY	39.4	62.4	88.8	64.4	63.9

Table 69, Average (1981-2010) of Minimum Temperatures in the Salt Lake FO

	Minimum Temperature (F)				
Location	**Winter**	**Spring**	**Summer**	**Autumn**	**Annual**
WENDOVER	20.4	41	63.5	41	41.6
RANDOLPH	4.2	24.8	42.5	24.2	24
SALT LAKE CITY	23	40.3	61.6	41.6	41.7

Table 70, Average (1981-2010) Precipitation for the Salt Lake FO

	Precipitation (in)					Snow Fall (in)				
Location	**Winter**	**Spring**	**Summer**	**Autumn**	**Annual**	**Winter**	**Spring**	**Summer**	**Autumn**	**Annual**
WENDOVER	0.81	1.42	0.81	1.01	4.05	NA	NA	NA	NA	NA
RANDOLPH	2.83	3.88	3.12	3.7	13.53	37.3	17.4	0.1	12.3	67.1
SALT LAKE CITY	3.91	5.73	2.28	4.18	16.1	36.4	10.8	0	9	56.2

Figure 48, Wind Rose for the Evanston Airport

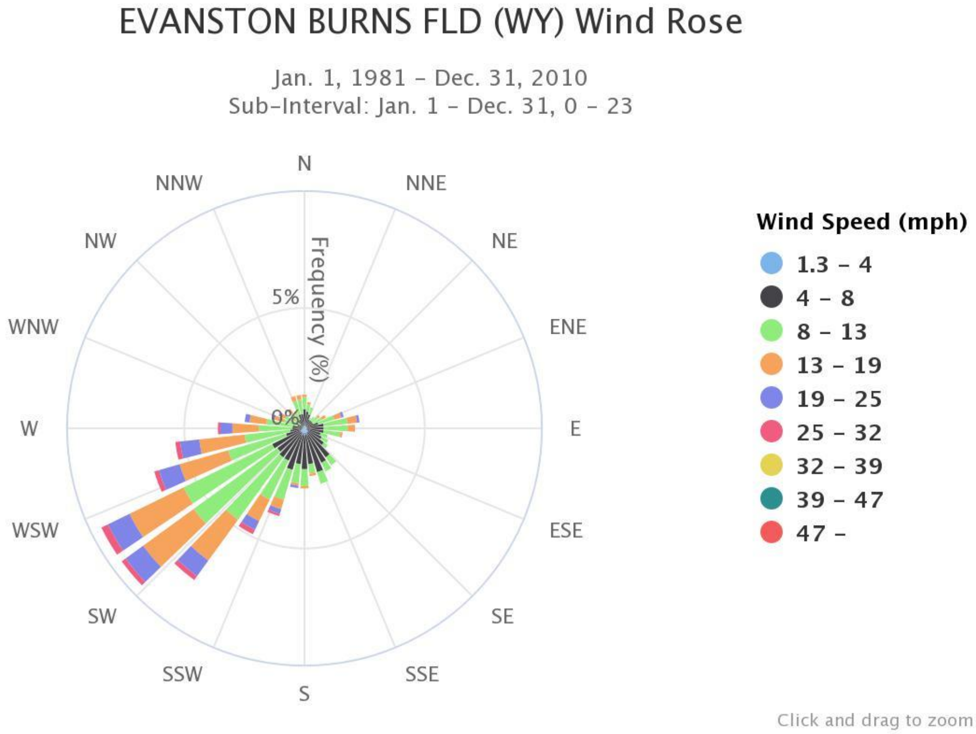


Figure 49, Wind Rose for the Salt Lake Airport

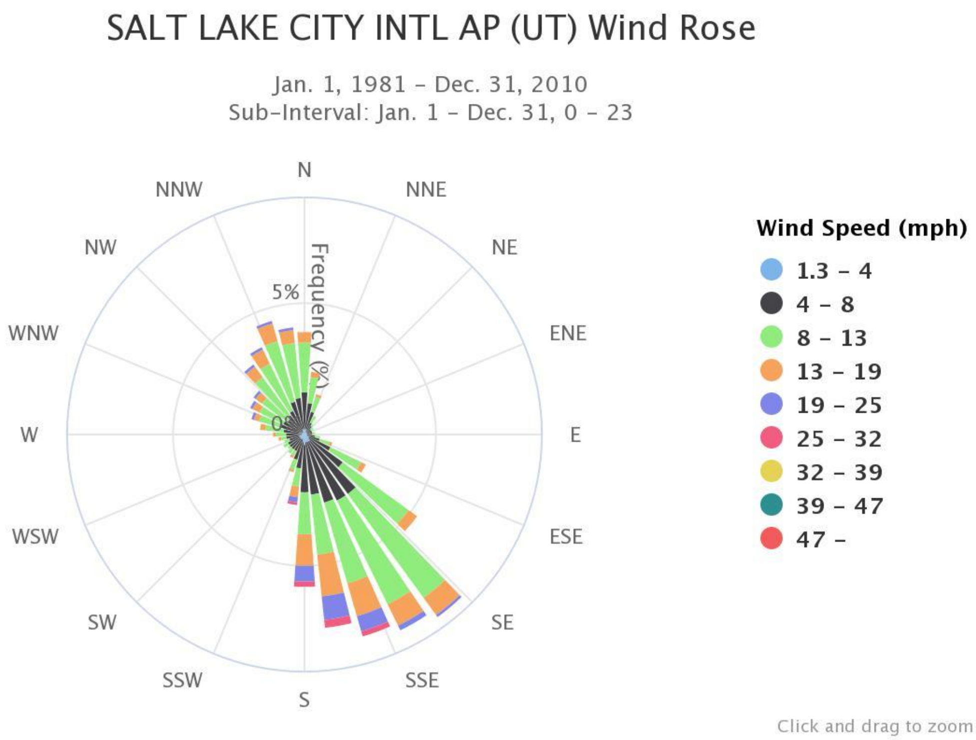


Figure 50, Wind Rose for the Wendover Airfield

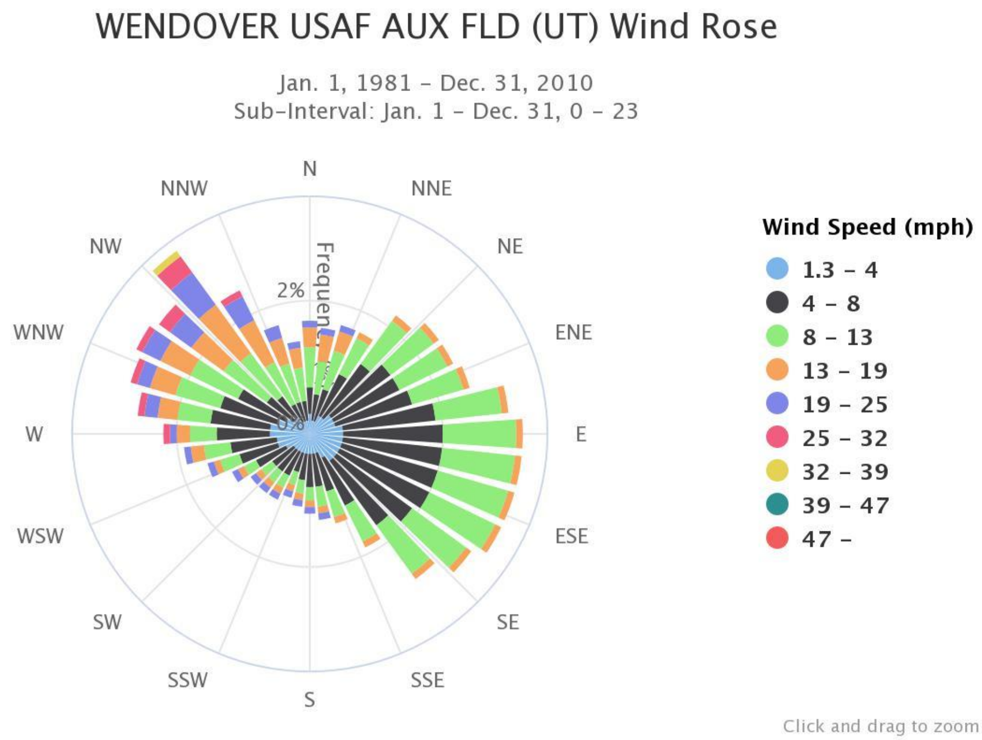


Figure 51, Wind Rose for Dugway Proving Ground

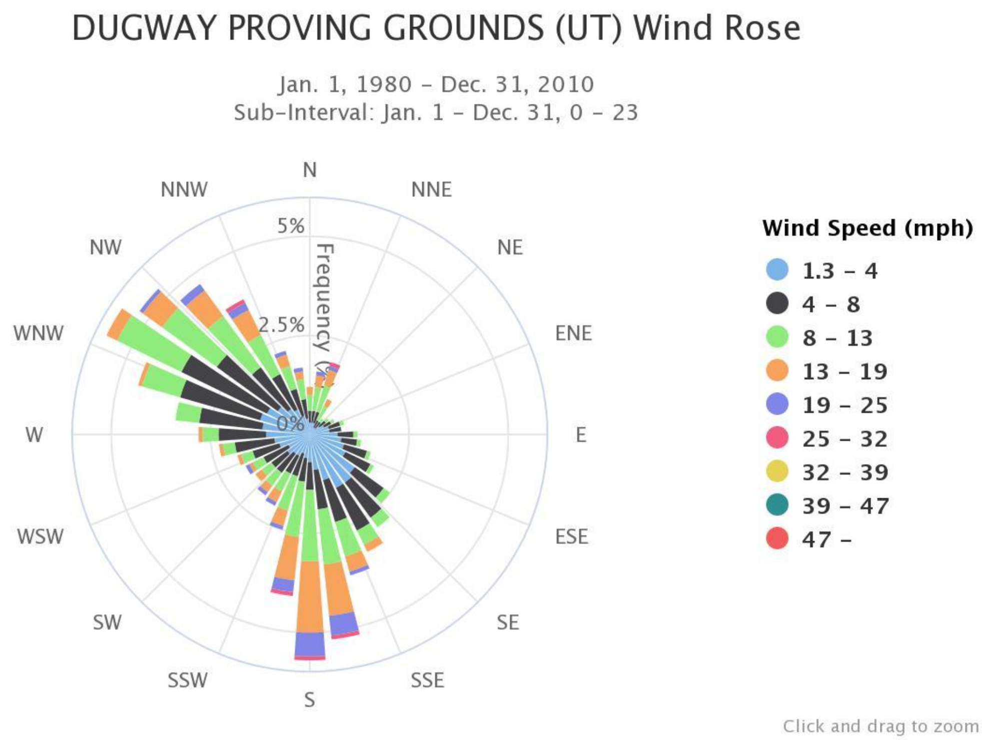


Table 71, Prevailing Wind Directions in the Salt Lake FO

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LOGAN (KLGU)	N	N	N	N	N	N	N	S	N	N	N	N	N
MILFORD (KMLF)	S	SSW	S	SSW	S	SSW	SSW	S	S	S	S	S	S
OGDEN (KOGD)	SSE	S	SSE	S	S	S	S	S	S	S	S	S	S
PROVO (KPVU)	NW	NW	NW	NW	NW	NW	SE	SE	SE	SE	SSE	SSE	NW
SALT LAKE CITY (KSLC)	S	S	SSE	SSE	SSE	S	SSE	SSE	SSE	SE	SE	S	SSE
WENDOVER (KENV)	NW	NW	E	NW	E	E	E	E	E	E	E	E	E
EVANSTON (KEVW)	SW	SW	WSW	WSW	WSW	WSW	SW	SW	SW	WSW	SW	SW	SW

Table 72, Average Wind Speed (mph) in the Salt Lake FO

STATION	Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
LOGAN (KLGU)	2001-2011	2.8	2.8	4.6	5.9	5.2	5	4.7	5	4.1	3.8	3.4	3.1	4.2
OGDEN (KOGD)	2001-2011	5.1	5.7	7.4	8.1	7.3	7.3	7	7.4	7.1	6.6	5.8	5.8	6.7
SALT LAKE CITY (KSLC)	2001-2011	6.2	6.9	8.6	9.6	8.6	8.8	8.5	9.3	8.6	7.8	6.9	6.8	8
PROVO (KPVU)	1996-2006	4.9	6	7.2	7.9	7.4	7.3	6.4	6.6	6.2	5.9	5.2	5	6.3
WENDOVER (KENV)	1996-2006	4.4	5.8	7.3	9	8.3	8.6	8	7.6	6.6	5.8	4.8	4.6	6.7
EVANSTON (KEVW)	2001-2011	9.7	9.1	10.2	10.8	10.1	10	8.9	9.3	9.3	9.7	9.3	9.9	9.7

Climate Trends

Historical yearly precipitation totals (1895-2017) and trends from the current climate normal period (1981-2010) for the Western, Northern Central and Northern Mountains climate divisions are shown in section 4.2.2 Figure 14, Figure 16, and Figure 18. Annual average temperature (1895-2017) and trends from the current climate normal period (1981-2010) are shown in Figure 21, Figure 23, and Figure 25 of section 4.2.2.

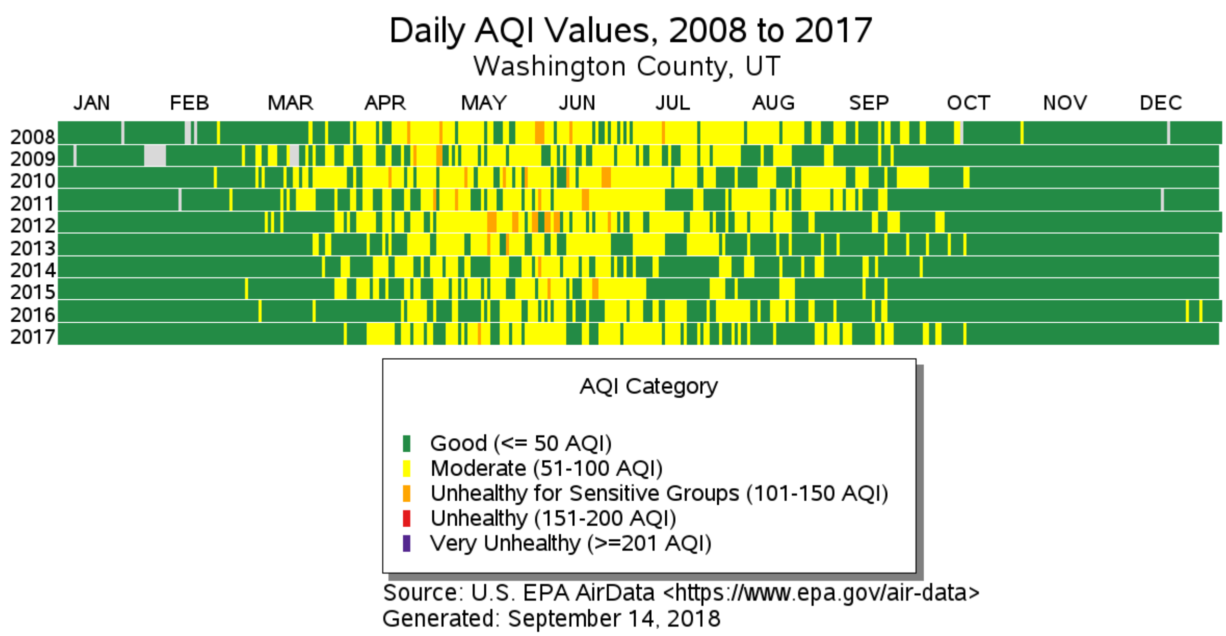
Appendix I (St. George Field Office)

Overview

Air quality in the St George Field Office is generally good. The area is in attainment or unclassifiable for all NAAQS pollutants. AQI summary information in Figure 52 below and in section 3.1 Table 4 show less than one percent of days having unhealthy air in Washington County. Pollutants of concern are NO_2, ozone, and $PM_{2.5}$ since these are the pollutants that determined the AQI over the last three years.

Air Quality Index

Figure 52, AQI Summary Information for Washington County



County CAP Emissions

Table 73 below lists the 2014 emissions inventory of CAP by source for counties within the Salt Lake field office boundaries.

Table 73, 2014 Criteria Air Pollutant Emissions (tpy) by Source for the St George FO

County	Source	CO	NOx	PM10	PM2.5	SOx	VOCs
Washington	Area Sources	330.11	146.45	3,910.88	527.27	1.52	287.47
	Area Sources Oil and Gas	0.00	0.00	0.00	0.00	0.00	0.00
	Non-Road Mobile	1,537.14	147.51	22.21	20.95	1.23	477.56
	On-Road Mobile	2,650.00	880.60	209.69	70.92	3.53	270.00
	Point Sources	17.67	2.99	7.72	3.73	0.34	3.48
	Biogenics	1,679.96	0.00	0.00	0.00	0.00	11,416.92

County	Source	CO	NOx	PM10	PM2.5	SOx	VOCs
	Wildfires	0.00	0.00	0.00	0.00	0.00	0.00
	County Total	**6,214.88**	**1,177.55**	**4,150.50**	**622.87**	**6.62**	**12,455.43**

Downstream GHG Emissions

No recent well production information is available for Washington County in the UDOGM database. Statewide average oil well production and average gas well production (Table 13) should be used to estimate downstream GHG emissions for oil or gas well decisions in the St George Field Office.

Climate Normals

The St George Field Office is in the Dixie climate division of Utah. This area has the highest average temperatures in Utah. Prevailing wind directions are primarily from a west or east northeast direction. Table 74 lists average seasonal temperatures for cities within the St George field office boundaries, while Table 75 and Table 76 list the average maximum and minimum temperatures respectively. Average seasonal precipitation can be found in Table 77. Wind information is provided in Figure 53, Table 78, and Table 79.

Table 74, Average (1981-2010) Temperatures in the St George FO

Location	Average Temperature (F)				
	Winter	Spring	Summer	Autumn	Annual
ST. GEORGE	43.4	62.9	85.2	63.9	63.9

Table 75, Average (1981-2010) of Maximum Temperatures in the St George FO

Location	Maximum Temperature (F)				
	Winter	Spring	Summer	Autumn	Annual
ST. GEORGE	54.7	76.1	98.7	77.4	76.9

Table 76, Average (1981-2010) of Minimum Temperatures in the St George FO

Location	Minimum Temperature (F)				
	Winter	Spring	Summer	Autumn	Annual
ST. GEORGE	32.2	49.7	71.6	50.3	51

Table 77, Average (1981-2010) Precipitation for the St George FO

Location	Precipitation (in)	Snow Fall (in)

	Winter	**Spring**	**Summer**	**Autumn**	**Annual**	**Winter**	**Spring**	**Summer**	**Autumn**	**Annual**
ST. GEORGE	3.49	1.94	1.41	1.96	8.8	1.1	0.2	0	0.1	1.4

Figure 53, Wind Rose for the St George Airport

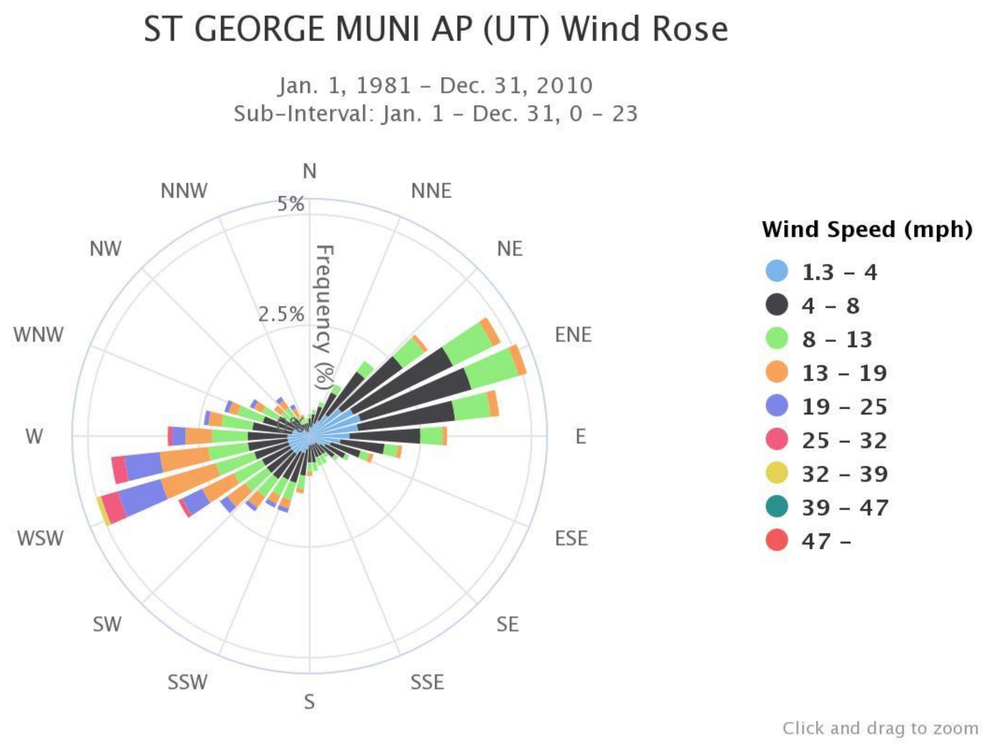


Table 78, Prevailing Wind Directions in the St George FO

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
ST. GEORGE (KSGU)	E	ENE	ENE	W	W	W	W	ENE	ENE	ENE	E	E	ENE

Table 79, Average Wind Speed (mph) in the St George FO

STATION	Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
ST. GEORGE (KSGU)	1996-2006	3.4	4.6	5.8	7.7	8.3	8.5	7.8	7.3	6.2	4.7	3.4	3.2	5.9

Climate Trends

Historical yearly precipitation totals (1895-2017) and trends from the current climate normal period (1981-2010) for the Dixie climate division is shown in section 4.2.2, Figure 15. Annual average temperature (1895-2017) and trends from the current climate normal period (1981-2010) is shown in Figure 22 of section 4.2.2.

Appendix J (Vernal Field Office)

Overview

Air quality in the Vernal Field Office is a concern. Portions of Duchesne and Uintah Counties have been designated as nonattainment for ozone. Beginning in August 2019 a general conformity determination is needed for all BLM approved or funded project occurring within the NAA. AQI summary information is shown in Figure 54, Figure 55, Figure 56, and section 3.1 Table 4. Over the last three years two percent of days have had unhealthy air in both Duchesne and Uintah Counties. Pollutants of concern for the field office are NO_2, ozone, $PM_{2.5}$, and VOCs since these are the pollutants that determined the AQI over the last three years.

Air Quality Index

Figure 54, AQI Summary Information for Daggett County

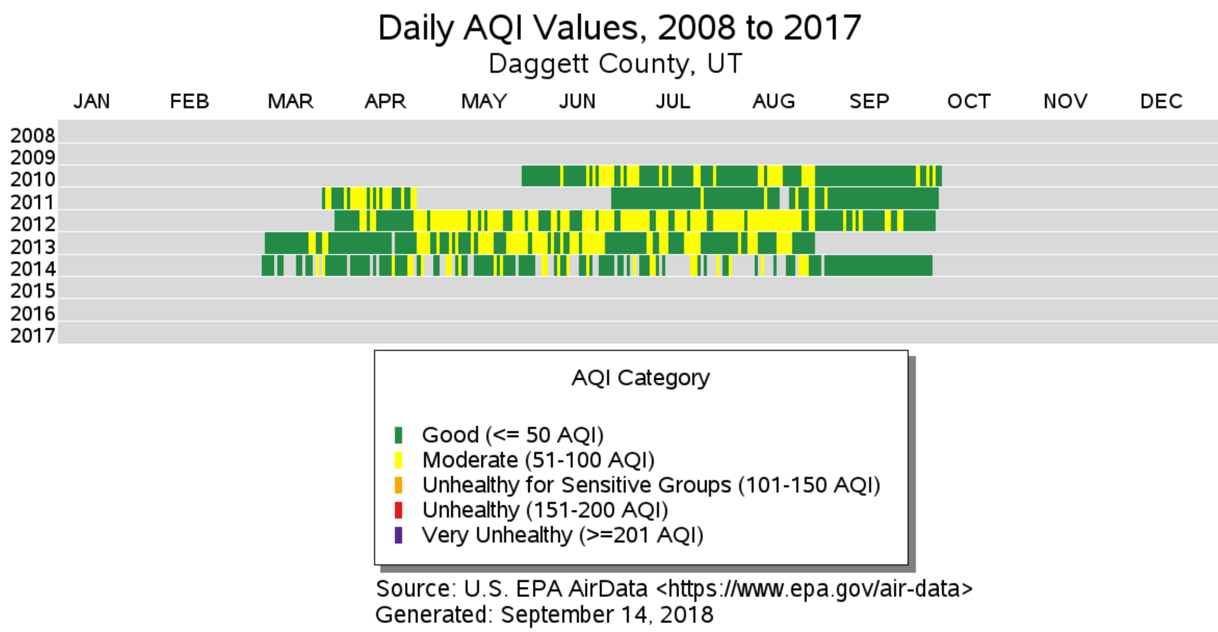


Figure 55, AQI Summary Information for Duchesne County

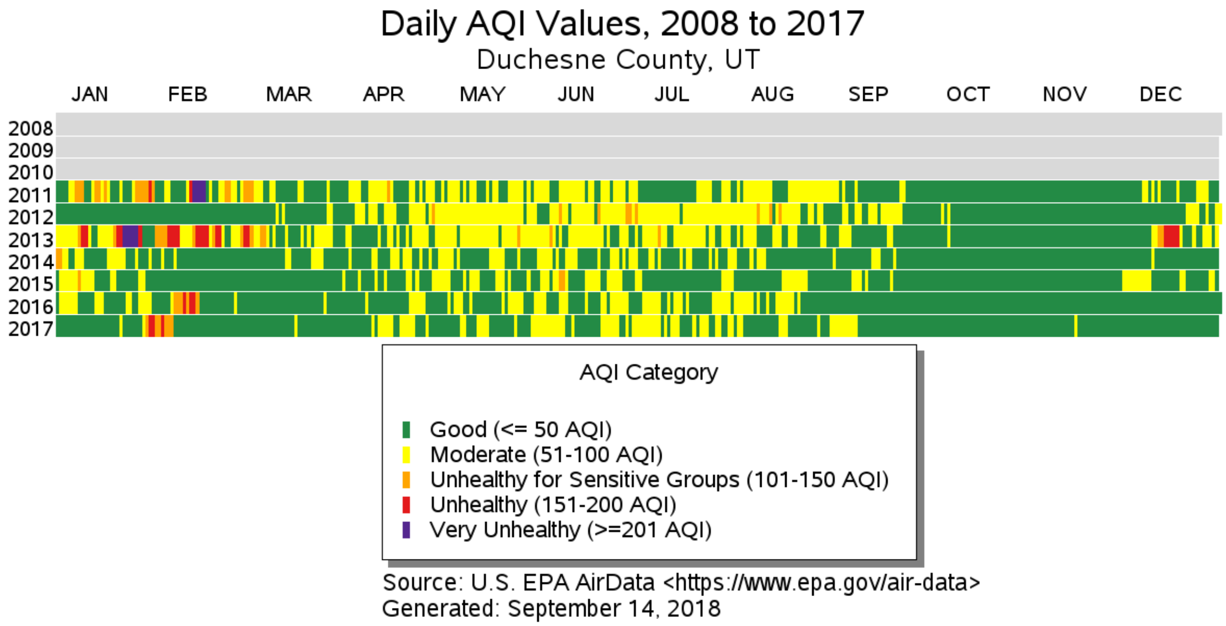
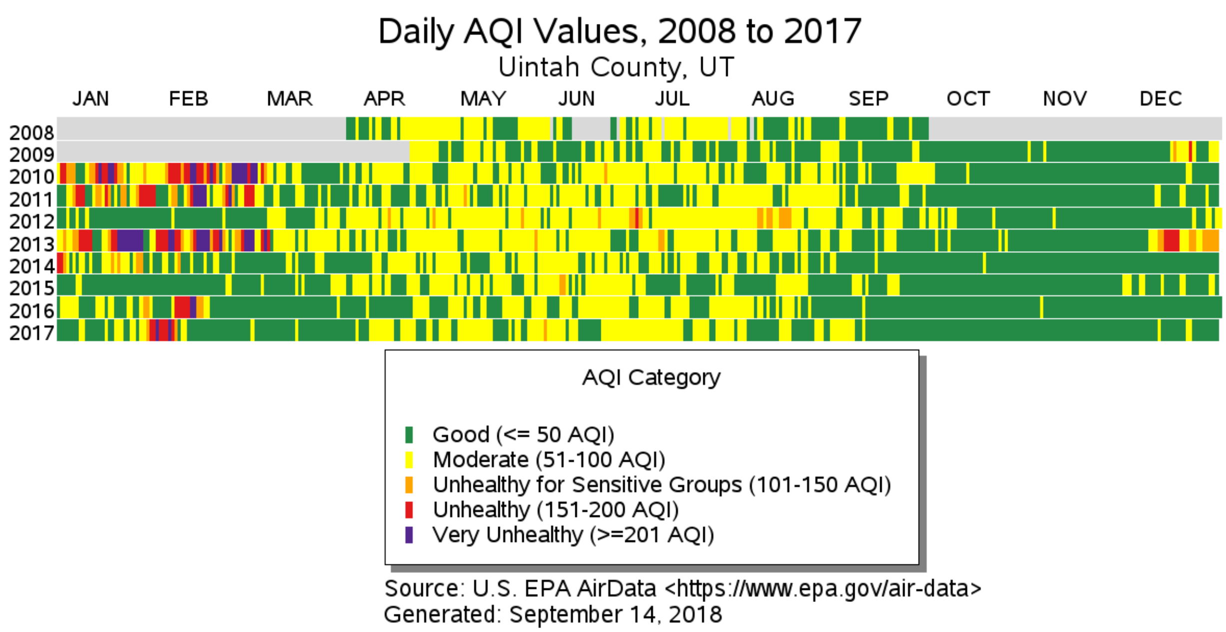


Figure 56, AQI Summary Information for Uintah County



County CAP Emissions

Table 80 below lists the 2014 emissions inventory of CAP by source for counties within the Vernal field office boundaries.

Table 80, 2014 Criteria Air Pollutant Emissions (tpy) by Source for the Vernal FO

County	Source	CO	NOx	PM10	PM2.5	SOx	VOCs
Daggett	Area Sources	359.29	228.91	2,273.69	353.08	5.79	124.34
	Area Sources Oil and Gas	0.00	0.00	0.00	0.00	0.00	0.00
	Non-Road Mobile	299.76	307.10	11.52	11.16	2.74	27.38
	On-Road Mobile	2,427.00	1,427.00	116.58	55.39	3.11	251.40
	Point Sources	45.08	103.15	97.57	26.16	2.97	7.35
	Biogenics	5,014.17	0.00	0.00	0.00	0.00	24,255.87
	Wildfires	0.00	0.00	0.00	0.00	0.00	0.00
	County Total	**8,145.30**	**2,066.16**	**2,499.36**	**445.79**	**14.61**	**24,666.34**
Duchesne	Area Sources	752.86	370.61	5,526.07	756.94	3.05	312.46
	Area Sources Oil and Gas	6,553.02	7,022.73	360.98	243.57	138.38	65,953.10
	Non-Road Mobile	1,271.76	111.24	18.67	17.56	0.32	336.27
	On-Road Mobile	2,045.00	781.00	230.57	76.19	2.88	225.46
	Point Sources	170.84	1,105.24	90.00	15.59	2.22	146.63
	Biogenics	4,190.77	0.00	0.00	0.00	0.00	21,165.88
	Wildfires	97.79	2.78	11.83	10.65	0.00	16.70
	County Total	**15,082.0**	**9,393.60**	**6,238.12**	**1,120.50**	**146.85**	**88,156.50**
Uintah	Area Sources	841.58	510.45	8,875.41	1,265.22	2.97	453.31
	Area Sources Oil and Gas	6,989.27	7,515.35	340.76	251.68	110.67	90,142.03
	Non-Road Mobile	1,679.01	161.52	18.30	17.36	0.57	264.30
	On-Road Mobile	3,090.00	1,149.00	366.79	118.81	4.63	334.80
	Point Sources	60.71	55.92	3.43	2.95	3.48	25.58
	Biogenics	6,793.31	0.00	0.00	0.00	0.00	31,661.88
	Wildfires	1,956.88	55.71	236.78	213.10	0.00	334.27
	County Total	**21,410.8**	**9,447.95**	**9,841.47**	**1,869.12**	**122.32**	**123,216.2**

Downstream GHG Emissions

Estimated production data for Daggett, Duchesne, and Uintah Counties are shown in Table 81. Total number of wells in the county are listed. Each well is considered to produce both oil and gas, and the average production for both is used to calculate total downstream GHG emissions. Estimated GHG emissions are in metric tons (MT) CO_2e and are based on the production and equivalency emission factors from the EPA.

Table 81, Well Production and Downstream GHG Emission Estimates for Wells in the Vernal FO Area

County	Total Oil (bbl)	Total Gas (mcf)	Producing Wells in County	Average Oil Production	Average Gas Production	MT CO_2e per well
Daggett	618	946,900	18	35	54,109	2,991
Duchesne	13,874,773	38,343,985	2847	4,873	13,467	2,836
Uintah	7,800,040	258,155,443	7012	1,112	36,815	2,503

Data source - https://oilgas.ogm.utah.gov/oilgasweb/publications/monthly-rpts-by-cnty.xhtml

Annual oil and gas production averaged over the last ten years (2008-2017)

Producing wells is determined by averaging the number of producing wells over the last ten year (2008-2017).

Oil well GHG indirect emission factor: 0.43 MT CO_2e per barrel (EPA, 2018)

Gas well GHG indirect emission factor are averaged from: 0.0551 MT CO_2e per million cubic feet (EPA, 2018)

There is some uncertainty in estimates of oil and gas production and ultimately downstream GHG emission estimates. Production can vary by well and from one year to the next. To better understand the range of potential downstream GHG emissions the standard deviation of annual productions is calculated from 2008 to 2017. Statistically, one standard deviation will include about 68% of the wells used to calculate the mean and two standard deviations will cover 95%. In Daggett County the annual standard deviation of oil and gas production per well is 11 bbl/yr and 19,902 mcf/yr respectively. In Duchesne County the standard deviation in annual production is 1,305 bbl/yr for oil and 2,417 mcf/yr for gas. While in Uintah County the standard deviation in annual production is 630 bbl/yr for oil and 11,116 mcf/yr for gas. For Daggett, Duchesne, and Uintah Counties this results in a per well range of downstream GHG emissions of ±1,101 MT CO_2e/yr, ±694 MT CO_2e/yr, and ±883 MT CO_2e/yr respectively.

Climate Normals

The Vernal Field Office is split between the Northern Mountains and Uinta Basin climate divisions of Utah. Most of BLM managed lands fall inside the Uinta Basin climate division. Lands in Daggett County are in the Northern Mountain division and on average experience have cooler temperatures and more precipitation. Prevailing wind directions are primarily from a westerly direction throughout the year. Table 82 lists average seasonal temperatures for cities within the Vernal field office boundaries, while Table 83 and Table 84 list the average maximum and minimum temperatures respectively. Average seasonal precipitation can be found in Table 85. Wind information is provided in Figure 57, Table 86, and Table 87.

Table 82, Average (1981-2010) Temperatures in the Vernal FO

	Average Temperature (F)				
Location	**Winter**	**Spring**	**Summer**	**Autumn**	**Annual**
VERNAL	22.1	47.1	69.3	47.5	46.6
MYTON	20.9	47.9	69.8	48	46.8

Table 83, Average (1981-2010) of Maximum Temperatures in the Vernal FO

Location	Maximum Temperature (F)				
	Winter	Spring	Summer	Autumn	Annual
VERNAL	31.5	59.6	84.3	60	59
MYTON	34.3	64	87.5	64.1	62.6

Table 84, Average (1981-2010) of Minimum Temperatures in the Vernal FO

Location	Minimum Temperature (F)				
	Winter	Spring	Summer	Autumn	Annual
VERNAL	12.7	34.6	54.2	35	34.2
MYTON	7.4	31.8	52.1	31.9	30.9

Table 85, Average (1981-2010) Precipitation for the Vernal FO

Location	Precipitation (in)					Snow Fall (in)				
	Winter	Spring	Summer	Autumn	Annual	Winter	Spring	Summer	Autumn	Annual
VERNAL	1.66	2.39	2.2	3.06	9.31	14.3	1.6	0	1.6	17.5
MYTON	1.12	1.78	1.8	2.27	6.97	7.5	1.7	0	1.1	10.3

Figure 57, Wind Rose from the Vernal Airport

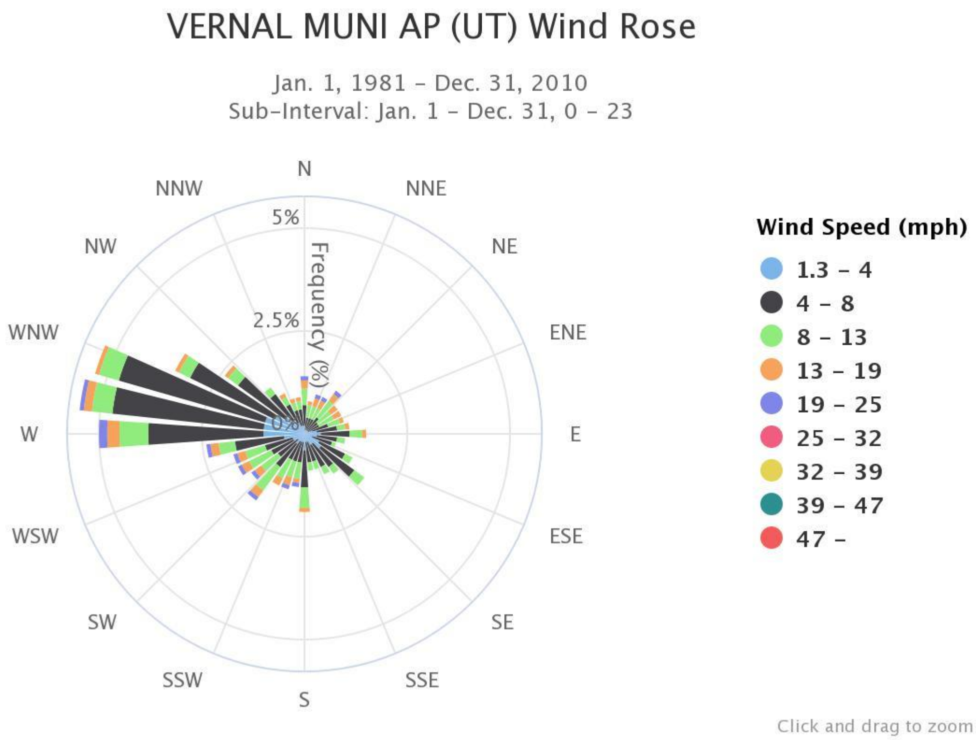


Table 86, Prevailing Wind Directions in the Vernal FO

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
VERNAL (KVEL)	W	W	WNW	W	W	W	W	W	W	W	WNW	W	W

Table 87, Average Wind Speed (mph) in the Vernal FO

STATION	Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
VERNAL (KVEL)	2001-2011	2.5	3.5	5.4	7	6.5	6.3	5.5	5.4	5.1	4.6	3.9	2.7	4.8

Climate Trends

Historical yearly precipitation totals (1895-2017) and trends from the current climate normal period (1981-2010) for the Northern Mountains and Uinta Basin climate divisions are shown in section 4.2.2, Figure 18 and Figure 19. Annual average temperature (1895-2017) and trends from the current climate normal period (1981-2010) are shown in Figure 25 and Figure 26 of section 4.2.2.